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VIGNETTE

H. Russell Ogden

The requirements upon materials are rising and, to keep up with demand, metallurgists are striving to reach the ultimate properties of metals. H. Russell Ogden cites high purity as the key to the alloys that are needed. "When we conduct research with pure metals," he states, "we can be sure that their inherent properties are not being masked. Moreover, studies on high-purity metals led us to principles that are basic and that hold up over the years. This approach has proved especially valuable in the study of refractory metals for space-age use, enabling us to learn what happens when they are subjected to extreme changes in temperature".

In 1945, Russ joined the Battelle staff, having received a B.S. in physical metallurgy from Michigan College of Mining Technology and an M.S. in the same field from Ohio State University. He immediately entered into research on the physical metallurgy of titanium and the development of titanium alloys. In that research, Russ was one of a group of metallurgists working with high-purity titanium. The high-purity approach enabled correlation of the metal's basic properties among mechanical properties, heat treatment, and microstructure. In these earlier years, he also participated in studies of the physical metallurgy of refractory metals, including tantalum, columbium, molybdenum, and tungsten, as well as of alloys of the more common metals, lead and zinc. And having helped to develop the alloys (his name appears on 46 patents granted and pending), he aided in the investigation of fabrication and production processes for most of the compositions.

Among the significant studies recently completed by Russ and his colleagues in his nonferrous metallurgy group may be mentioned: a technique for dispersion strengthening, long applied to tungsten, which has been proved successful also with conventional metals such as lead; a roll-bonded sandwich structure which can be fabricated from titanium, aluminum, stainless steel, molybdenum, and other metals; and studies of rhenium alloys as thermocouple materials and of rhenium as an addition to improve the ductility of molybdenum, tungsten, and chromium. Important research in progress includes: work on tantalum alloys with excellent cryogenic properties as well as very good strength at temperatures above 2500 F; development of protective coating systems to prevent oxidation of tantalum above 2500 F; studies on chromium-base alloys; and investigations of the ductile-brittle behavior of high-purity chromium.

Currently, Russ is working with both the Titanium Alloy Sheet Rolling and Refractory Metal Sheet Rolling Panels of the Materials Advisory Board. He is also an annual lecturer at New York University's Titanium Symposium and has been active in the affairs of the American Society of Metals and the American Institute of Mining, Metallurgical, and Petroleum Engineers. His research has led to authorship and coauthorship of some two score articles and papers as well as chapters in *Rare Metals Handbook*, *Problems in Nuclear Engineering*, and *The Reactor Handbook*.

Russ and his wife, Helen, enjoy traveling. Having seen the U.S. and the Caribbean area, they are now planning a trip to Europe. As a travel by-product they collect stamps to learn more about countries they may visit. At home, the garden and house help to keep Russ busy.

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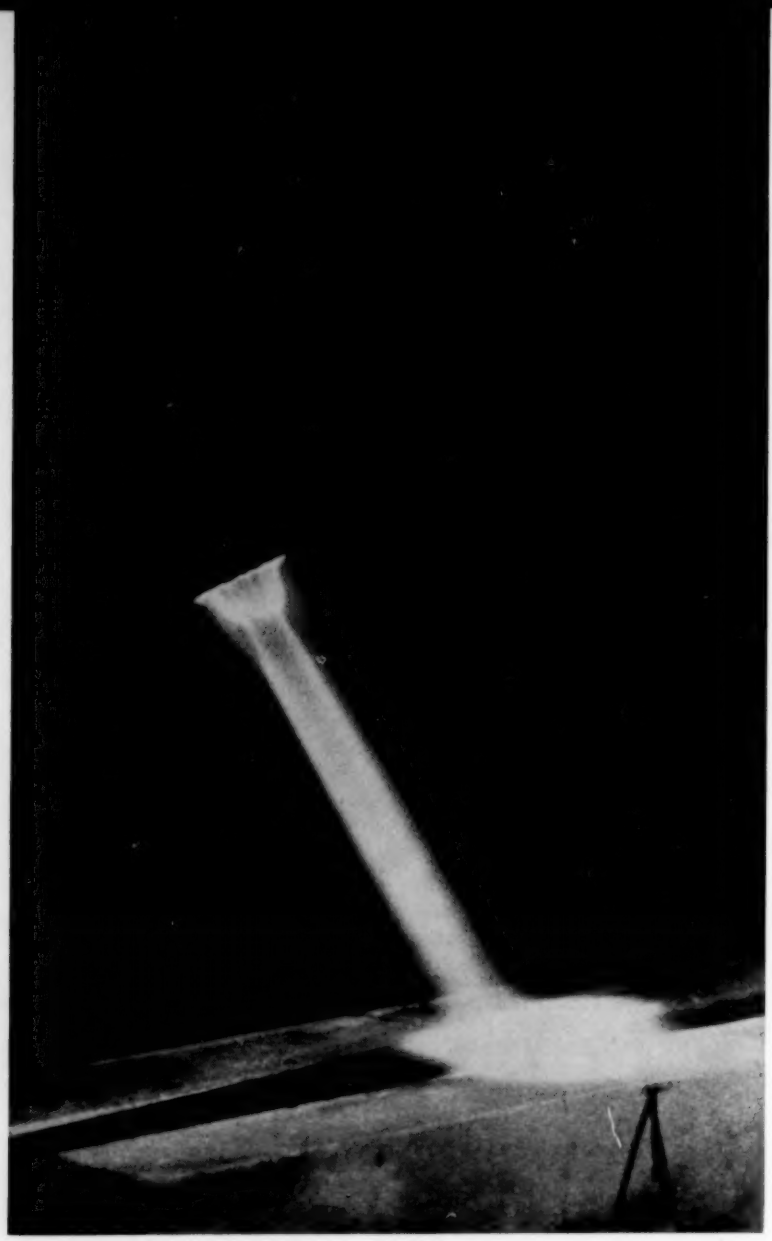


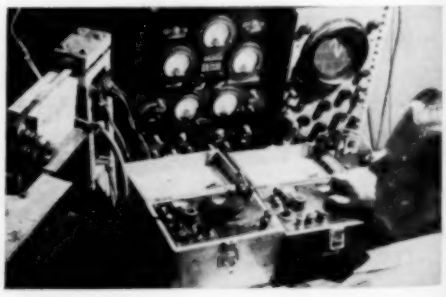
IMPROVED STRAIN-GAGE MATERIALS FOR HIGH-TEMPERATURE STUDIES

Since jet-engine turbine blades are exposed to high temperatures, instrumentation used in their study—particularly strain gages--must stand up to comparable environments. Thus, strain gages used in the study of blades on operating turbines, to provide accurate data, must remain firmly fastened even in the face of vibration, high temperatures, and temperature gradients.

Battelle ceramists are currently conducting research looking to the development of a cement for securely holding strain gages under such conditions. The study, sponsored by Pratt & Whitney Aircraft, Division of United Aircraft Corporation, seeks:

- A cement to hold strain gages on a moving turbine blade with a thermal gradient of from well above 2000 F on one side to well below 2000 F on the other;
- Properties of the cement relating to thermal shock, electrical resistance, ability to bond to metal, and reaction to humidity in the atmosphere;
- Strain-gage wire and leads that will stand up best under such conditions;
- Techniques for manufacturing strain gages and for applying them to turbine blades.

For study, as shown in the large photo, strain gages are fastened with cement to a vibrating metal bar heated by a torch on one side and cooled by air on the other to produce a proper thermal gradient. The instruments watched by Frank J. Buffington, in recording the behavior of the strain gages, show the effectiveness of the cement holding them. M. Jack Snyder is also participating in the research.



Structure and Goal of Quantum Chemistry - I

In this first of a two-part article, the author discusses the relationships between classical and quantum mechanics and considers formulations of the fundamental rules of quantum mechanics pertinent to an understanding of chemical and related binding forces.

by LAURENS JANSEN

QUANTUM CHEMISTRY, the chemical branch of quantum mechanics, is just over thirty years old. It started with the treatment of the hydrogen molecule by Heitler and London (1927) and had as its goal the accurate prediction of all relevant properties of a hypothetical molecule prior to its synthesis in the laboratories.

During its development, quantum chemistry has strongly influenced chemical thinking and achieved a number of very significant results. However, the results have often been of a semiempirical nature. Attempts to render these results more precise on the basis of fundamental theory have mostly met with formidable difficulties and have led to the discovery of some curious properties of the approximate solutions.

The following article constitutes an attempt to sketch, in rough outlines, the structure of quantum chemistry in its relation to quantum mechanics. The classical analogies plus the requirement of noncommutability of the dynamical variables lead to quantization aspects of the theory. The mathematical manipulations evolve on the basis of the theory of linear transformations on a Hilbert space.

The complexity of the fundamental equations necessitates the use of approximation methods, among which, owing to the nature of quantum chemical problems, the variation method has high preference. These characteristics cause some remarkable properties in the approximate solutions and determine the limits of what can be reasonably asked of the theory. In this connection, special caution must be exercised if one deals with operators which are not bounded with respect to the usual norm topology (example: the electric dipole moment).

By common understanding, quantum chemistry is that part of the physical sciences devoted to the application of quantum mechanical methods to specifically chemical problems. Such problems involve chemical binding, structure and reactivity of molecules, causes for the occurrence of activation energies in chemical reactions, and the like.

A characteristic feature of quantum chemistry lies in the fact that it deals with systems involving a relatively small number of bound electrons. As such, the theory has a definitely local character on a molecular scale, and is applicable, for example, also to solid state physics whenever local characteristics play a role. Thus, although most solid-state aspects cannot be classified as belonging to the realm of quantum chemistry, some of the theoretical methods developed for the description of typically chemical phenomena can also be applied to local effects in solids.

Quantum chemistry was born shortly after the origin of its mother science, quantum mechanics. Historically, the first purely chemical problem treated with quantum mechanical means was that of the hydrogen molecule by Heitler and London (1927), although Heisenberg had, one year earlier, already discussed the helium atom along similar lines. The essentially new feature was here the discussion of a "many"-electron system (2 electrons in He, and H_2), instead of a system involving only a single electron (hydrogen atom).

Although Heitler and London arrived at values for the binding energy and the equilibrium distance between the two protons of the hydrogen molecule, which were only of the right order of magnitude and not very precise, one could say that the homopolar

chemical bond, a mystery for the pre-quantum understanding of matter, had received a satisfactory physical interpretation. It is important to note that the binding between the two hydrogen atoms comes about through an "exchange effect," which has no classical analogue. It results from a symmetry property of the wave function for the molecule, induced by the indistinguishability in principle of the two electrons. As a consequence, there is a net increase of electronic charge in the region between the two protons (compared with a simple superposition of the charges of two free hydrogen atoms), which confirms the pre-quantum concept, developed by Lewis, that a homopolar (covalent) bond is associated with a pair of electrons. That such a bond is saturated follows further from the Pauli principle.

This initial triumph of quantum chemistry led the way to many applications of quantum mechanical methods to chemical problems, and to a great number of attempts to correlate the specific chemical terminology with purely theoretical concepts. The ultimate goal was to be able precisely to predict the essential properties of a hypothetical molecule, before it is synthesized in the laboratories. It is clear that, with this goal in mind, quantum chemistry acquired a status of high interest also for industrial applications.

The first period in this development ended with James' and Coolidge's accurate calculation of the ground-state energy of the hydrogen molecule (1933). In spite of their success, the work had taken three years, which made it clear that quick and precise results for more complicated systems could not be expected. In addition, the final solution for the wave function of the hydrogen molecule was obscure from a physical standpoint, and added nothing to an interpretation of the nature of the homopolar bond.

After 1933, two different methods of approach became distinguishable in quantum chemistry. On one hand, a large number of important, but qualitative or semiempirical, conclusions were reached on the basis of relatively simple theoretical treatments. Especially in the field of the unsaturated hydrocarbons with conjugated double bonds the crop of results has been very rich. On the basis of some drastic simplifications one arrives at theoretical expressions containing one or more parameters. If one now assumes that these parameters have the same values for different systems containing conjugated double bonds, then these values can be determined from a comparison with experimental data, and they can be used to predict the properties of other molecular systems of the same kind. Recently, some further striking advances have been achieved on the basis of the concept of many-center (instead of two-center) molecular orbitals applied to boron hydrides, complex compounds of the transition elements with unsaturated hydrocarbons, and other systems. For details, the reader is referred to a number of recent survey articles.[1)2)]

On the other hand, the numerous attempts directed towards rendering these conclusions more quantitative, to justify the simplifying assumptions, and to compute the values of the parameters starting from pure theory, led to a number of ingenious, powerful, and elegant formalisms, but they were relatively unsuccessful in providing the more accurate information desired. In addition, the many empirical rules derived in chemistry from the great wealth of experimental data have, in general, resisted ready explanation in terms of purely theoretical concepts. Thus, it may be said that the results of the application of quantum mechanical principles to the chemical problems are characterized by an extraordinary fertility of qualitative or semiempirical methods, whereas, from a standpoint of the basic theory, they possess a highly approximate character.

In view of this situation, we must admit that the ultimate goal of quantum chemistry is still far from its realization. On the other hand, it should be pointed out that we stand only at the beginning in the development of this branch of the physical sciences, and that most chemical problems possess a very high degree of complexity.

The fact that a theoretical chemist is usually relatively uninformed regarding the principles of quantum mechanics, as compared with a quantum physicist, adds to the complications which beset the development of quantum chemistry as a quantitative, not merely phenomenological, theory. In particular, the subtle, but essential difficulties involved in the appli-

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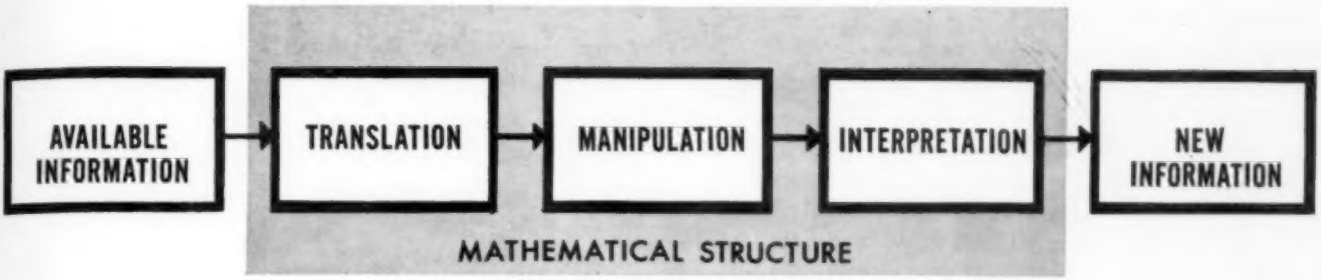
Dr. Jansen, has devoted most of his professional career to the study of molecular physics. His particular research interests have included the investigation of the structure of molecular crystals, intermolecular forces, and the theory of dielectric constants. In addition to his research activities, the author is currently serving as editor of a series of monographs in quantum chemistry. The present article is based upon lectures presented at the Third Summer School in Quantum Chemistry in Uppsala, Sweden, in 1960. Prior to joining the Battelle-Geneva staff, the author was associated with the Institute for Molecular Physics, at the University of Maryland, and later served as visiting professor at the University of Uppsala and at the Eidgenossische Technische Hochschule, in Zurich.

[1)] C. A. Coulson, "Dreissig Jahre Quantenchemie," *Oest. Chem. Zeitung 60,* (6) 153 (1959).

[2)] J. K. Syrkin and M. J. Djatkina, *Vestnik AN SSSR 6,* 13 (1959); German translation in *Naturw. Beitr. Sowjetwiss. 1,* 1 (1960).



cation of approximation methods to quantum mechanical problems are, almost without exception, unknown to theoretical chemists. The present article constitutes an attempt to draw the attention of theoretical chemists again to the foundations of the theory, and to sketch the limitations inherent in the type of approximation methods which are used in quantum chemistry.

In order to penetrate a little deeper into this complex of problems, two questions may be asked:

a. What is, in the framework of our basic assumptions, the reason for the formidable complexity of the fundamental equations?

b. Granting the outspoken approximate character of the solutions, what questions can one legitimately ask of a theory based on a limiting procedure? For example, if we have obtained a value for the energy of a molecular system to a certain degree of accuracy, what can be said about other quantities, the dipole moment of the molecule, or the electron charge distribution, for instance?

To shed some light on these questions, it is desirable to discuss first the physical and mathematical structures of quantum chemistry.[3]

Mathematical Structure of the Theory

The aim of a physical theory is to reproduce accurately results obtained by accurate experiments and to predict new results which are capable of precise experimental verification. Since experimental results are given in the form of numbers, a physical theory has to lead to such numbers, and not, for example, to symbols, or merely to relations between symbols.

In any application of a theory we start from certain available information concerning the system under study. This information must first be translated into equations between mathematical quantities which represent the state and the dynamical variables of the system (translation process). From these equations, new ones are deduced on the basis of the axioms and rules of manipulation for the mathematical quantities (manipulation process). The obtained, new equations must then be interpreted in terms of physical conditions concerning the system (interpretation process), leading finally to new information.

The initial and final stages ("available" information, and "new" information, respectively) are thus separated by a three-stage process; these three stages are determined by the mathematical structure of the theory. The diagram above illustrates the situation.

The classical analogies

To start with, we shall discuss some concepts of the classical mechanics of point systems, since in quantum mechanics direct analogies of many classical concepts are maintained. This applies, in particular, to the so-called energy-function of a system, also called *Hamilton function* or *Hamiltonian*.

Suppose that we are given a mechanical system of point particles which, at a starting time t_0, have known positions in configuration space, and known velocities. How does this system develop with time? The mass points of which the system is composed possess kinetic energy; further, the different point particles will, in general, exert forces on each other. We assume that these forces may be written as (minus) the gradient of some potential function. If this is possible, then the system is called conservative.

Let the system have k degrees of freedom, i.e., we can choose k independent coordinates $q_1, q_2, \ldots q_i, \ldots q_k$ which specify the state of the system in configuration space at any time. These coordinates, q_i, are called *generalized coordinates* (*of Lagrange*). To these, there correspond k generalized velocities $\dot{q}_1, \dot{q}_2, \ldots, \dot{q}_i, \ldots \dot{q}_k$; together, the $2k$ variables $q_1, q_2, \ldots, q_k; \dot{q}_1, \dot{q}_2, \ldots, \dot{q}_k$, given at one time, determine the state of the system at any other time, provided the forces between the particles are known.

[3] Elements of the following sections II and III can be found, in much more detail, in many standard works on physics, e.g.

R. C. Tolman: *The Principles of Statistical Mechanics*, Clarendon Press, Oxford, 1938;

J. von Neumann: *Mathematical Foundations of Quantum Mechanics*, Princeton University Press, 1955;

P. A. M. Dirac: *The Principles of Quantum Mechanics*, (3d Edition), Clarendon Press, Oxford, 1947;

E. C. Kemble: *The Fundamental Principles of Quantum Mechanics*, McGraw-Hill Book Co., New York, 1937.

The equations of motion, which describe the system's development, may be derived in two ways:

1. from Hamilton's principle of least action, *via* a variation procedure;
2. from Newton's force law.

We choose the first method, since it is more useful for later purposes. Hamilton's principle states that there exists, for each mechanical system, a time-integral

$$S=\int_{t_1}^{t_2} L\,dt,$$

called action integral, which has an extremal value for the actual motion of the system. That is, if we keep the initial state (at time t_1) and the final state (at time t_2) of the system fixed, then the system will develop from initial to final state in such a way that S is an extremum. The equations of motion are then determined from the variational principle

$$\delta S=\int_{t_1}^{t_2} \delta L\,dt=0;$$

L is called the *Lagrangian* function, or the Lagrangian. Now $L=L(q_i, \dot{q}_i)$, assuming that L is not explicitly a function of time (i.e. we consider only so-called *skleronomous* systems); then

$$\delta S=0=\Sigma_i \int_{t_1}^{t_2}\left\{\frac{\partial L}{\partial q_i}\delta q_i+\frac{\partial L}{\partial \dot{q}_i}\delta\dot{q}_i\right\}dt=0.$$

We can write

$$\delta\dot{q}_i=\delta\frac{dq_i}{dt}=\frac{d}{dt}\delta q_i;$$

then the integral $\int_{ti}^{t_2}\frac{\partial L}{\partial \dot{q}_i}\left(\frac{d}{dt}\delta q_i\right)\,dt$ can be integrated in parts:

$$\int_{t_1}^{t_2}\frac{\partial L}{\partial \dot{q}_i}\left(\frac{d}{dt}\delta q_i\right)dt=\left[\frac{\partial L}{\partial \dot{q}_i}\delta q_i\right]_{t_1}^{t_2}-\int_{t_1}^{t_2}\left(\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i}\right)\delta q_i\,dt.$$

But the first expression on the right is zero, because we keep the limits fixed ($\delta q_i=0$ at t_1 and t_2). In total, we have

$$\delta S=\Sigma_i\int_{t_1}^{t_2}\left\{\frac{\partial L}{\partial q_i}-\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i}\right\}\delta q_i\,dt=0$$

which means, since the δq_i are by definition independent, that

$$\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i}-\frac{\partial L}{\partial q_i}=0\ ;\ i=1, 2, \ldots, k.$$

These are the Lagrange equations of motion for conservative systems. By choosing $L=T-U$, where T is the kinetic energy of the system, and U is the potential energy, we obtain the correct equations of motion for a mechanical system of point particles.

Instead of the generalized velocities, $\dot{q}_i$, we define generalized *momenta*, p_i, by

$$p_i=\partial L/\partial\dot{q}_i\ ;\ i=1, 2, \ldots, k.$$

Then we obtain

$$\dot{p}_i=\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_i}=\frac{\partial L}{\partial q_i}.$$

Also, we introduce, instead of L, the Hamilton function (Hamiltonian), H, by

$$H=\Sigma_i p_i\dot{q}_i-L.$$

Then we have

$$\delta H=\Sigma_i\left\{\delta p_i\cdot\dot{q}_i+\overbrace{p_i\cdot\delta\dot{q}_i-\frac{\partial L}{\partial\dot{q}_i}\delta\dot{q}_i}^{0}-\frac{\partial L}{\partial q_i}\delta q_i\right\}$$

$$=\Sigma_i\left\{\dot{q}_i\cdot\delta p_i-\frac{\partial L}{\partial q_i}\delta q_i\right\}=\Sigma_i\left\{\dot{q}_i\cdot\delta p_i-\dot{p}_i\cdot\delta q_i\right\}.$$

As a result, we obtain the two Hamilton equations of motion (for conservative, skleronomous systems):

$$\dot{q}_i=\partial H/\partial p_i\ ;\ \dot{p}_i=-\partial H/\partial q_i\ ;\ i=1, 2, \ldots, k.$$

We note that, with

$$L=T-U,\ p_i=\partial L/\partial\dot{q}_i=\partial T/\partial\dot{q}_i,$$

since the potential energy does not depend on the velocities. If the system is skleronomous, then T is a homogeneous quadratic function of the $\dot{q}_i$.
In that case we have:

$$\Sigma_i p_i\cdot\dot{q}_i=\Sigma_i\frac{\partial T}{\partial\dot{q}_i}\cdot\dot{q}_i=2T\ \text{(Euler)}.$$

With the help of Euler's theorem we rewrite H:

$$H=\Sigma_i p_i\cdot\dot{q}_i-L=\Sigma_i\frac{\partial T}{\partial\dot{q}_i}\cdot\dot{q}_i-L=2T-(T-U)=T+U.$$

Therefore, H is the total energy of the system.

We can also determine the rate of change with time of any dynamical variable $F(p_i, q_i; t)$:

$$\dot{F}=\Sigma_i\left\{\frac{\partial F}{\partial q_i}\dot{q}_i+\frac{\partial F}{\partial p_i}\dot{p}_i\right\}+\frac{\partial F}{\partial t}$$

$$=\Sigma_i\left\{\frac{\partial F}{\partial q_i}\frac{\partial H}{\partial p_i}-\frac{\partial F}{\partial p_i}\frac{\partial H}{\partial q_i}\right\}+\frac{\partial F}{\partial t}$$

$$=[F, H]_{PB}+\frac{\partial F}{\partial t},$$

where

$$[F, H]_{PB}=\Sigma_i\left\{\frac{\partial F}{\partial q_i}\frac{\partial H}{\partial p_i}-\frac{\partial F}{\partial p_i}\frac{\partial H}{\partial q_i}\right\}$$

is called a *Poisson Bracket*. A special case occurs when F is not explicitly a function of time: $\frac{\partial F}{\partial t}=0$; then

$\dot{F}=[F, H]_{PB}$. If F is a constant of the motion, then $\dot{F}=0$: this means that its Poisson Bracket with H vanishes.

The concept of a Poisson Bracket (PB) applies to any two functions, u and v, of the dynamical variables p_i, q_i:

$$[u, v]_{PB} = \sum_i \left\{ \frac{\partial u}{\partial q_i}\frac{\partial v}{\partial p_i} - \frac{\partial u}{\partial p_i}\frac{\partial v}{\partial q_i} \right\}; \; i=1, 2, \ldots, k.$$

This definition is general, i.e., $[u, v]_{PB}$ is independent of the specific set of generalized coordinates and momenta which we choose for the system.

The PB's of the generalized coordinates and momenta, q_i, p_i, have the values:

$$[q_i, q_j]_{PB} = 0 \; ; \; [p_i, p_j]_{PB} = 0,$$

but

$$[q_i, p_j]_{PB} = \delta_{ij} \quad \text{(Kronecker-}\delta\text{)}.$$

Dynamical variables whose Poisson Bracket is equal to unity, are called *conjugate* variables. Example: p_i and q_i.

A quantum mechanical treatment of a problem begins with proposing an analogous classical mechanical problem, in the form of a certain, given, Hamilton function H $(q_1, \ldots, q_k; p_1, \ldots, p_k; t)$. The system has k degrees of freedom; the q_i are the generalized coordinates, the p_i the generalized momenta of the system (momenta conjugate to the coordinates q_i). The translation process consists of stipulating the nature of the mathematical quantities which represent the q_i and p_i.

In classical mechanics, the $2k$ quantities $q_1, \ldots, q_k$; $p_1, \ldots p_k$ determine a point in $2k$-dimensional Euclidean space. At a given time, t, they specify precisely the state of our system. The quantities q_i, p_i are pure numbers. In quantum mechanics, it is supposed that the $2k$ variables q_i, p_i are to be represented, not by pure numbers, but by *noncommuting* mathematical quantities. The transition to noncommuting variables has the phenomenal consequence that, therewith, *quantization aspects are introduced in the theory.*

The circumstance that two quantities, A and B, say, do not commute, is expressed by $AB \neq BA$, i.e., $AB-BA=[A, B]_- \neq 0$. We come now to the task of establishing the commutation rules for the dynamical variables q_i, p_i; i.e., we have to evaluate the expressions

$$[q_i, q_j]_-, \; [p_i, p_j]_-, \text{ and } [p_i, q_j]_- = -[q_j, p_i]_-.$$

Then, the commutation rules between any two quantities, A and B, which are functions of the q_i, p_i, follow (in principle) automatically. This task is accomplished by considering the classical analogue of the commutator $[A, B]_- = AB-BA$. This analogue in general dynamical theory is the Poisson Bracket, which has the following properties

$$[u, v] = -[v, u]$$
$$[u, c] = 0; \; c \text{ is a number}$$
$$[u_1+u_2, v] = [u_1, v]+[u_2, v]$$
$$[u, v_1+v_2] = [u, v_1]+[u, v_2]$$
$$[u_1 u_2, v] = [u_1, v]u_2+u_1[u_2, v]$$
$$[u, v_1v_2] = [u, v_1]v_2+v_1[u, v_2],$$

plus the following equation, called *Jacobi's identity*:

$$[u, [v, w]]+[v, [w, u]]+[w, [u, v]] = 0.$$

The analogy between the (quantum) commutator and the (classical) Poisson Bracket is illustrated by observing that the above relations for a PB are also satisfied by a commutator. This analogy supplies the background for the postulate that the role of the PB in classical mechanics is taken over by the commutator in quantum mechanics. *This is the fundamental theorem of quantum mechanics.*

In view of the circumstance that the dynamical variables in quantum mechanics do, in general, no longer commute, one has to take care in not stretching this postulate too far. But we must require, on the basis of the above postulate, that the values of the simplest PB's involving q_i, p_i should be the same as the values of the corresponding commutators in quantum theory.

It can be shown that a commutator, $[u, v]_- = uv-vu$, of two real dynamical variables, is purely imaginary.* Therefore, a commutator cannot be the direct analogue of a PB, but we have to divide the commutator by $i=\sqrt{-1}$, and then we can still multiply it by a c-number, i.e., a quantity which commutes with everything, without destroying the analogy. To obtain agreement with experiment, this real number has to be taken equal to $2\pi/h$ (h is Planck's constant). We therefore stipulate:

$$[q_i, q_j]_- = 0; \; [p_i, p_j]_- = 0$$
$$[q_i, p_j] = ih\delta_{ij}/2\pi$$

*In going from numbers to noncommuting quantities, the concept of complex conjugate has also to be generalized; we call this more general notion the adjoint of a variable, anticipating the representation of the dynamical variables by operators (linear transformations). Let A,B be two variables, α and β two scalar quantities. Then the adjoints, $A^\dagger$, $B^\dagger$ of A and B are defined by the following rules:

$(A+B)^\dagger = A^\dagger+B^\dagger$ corresponding to $(\alpha+\beta)^* = \alpha^*+\beta^*$;

but $\left.\begin{matrix}(\alpha A)^\dagger = \alpha^* A^\dagger \\ (AB)^\dagger = B^\dagger A^\dagger\end{matrix}\right\}$ corresponding to $(\alpha\beta)^* = \alpha^*\beta^*$.

A real scalar, $\alpha^* = \alpha$, corresponds to a self-adjoint variable: $A^\dagger = A$; a purely imaginary scalar, $\alpha^* = -\alpha$, corresponds to a variable for which $A^\dagger = -A$. Let now A, B be self-adjoint, and $[AB]_- = AB-BA = C$. Then we have: $C^\dagger = [AB]^\dagger_- = B^\dagger A^\dagger - A^\dagger B^\dagger = BA-AB = -C$, i.e. the generalization of a purely imaginary number.

and call these the fundamental quantum conditions for the dynamical variables p_i, q_i in quantum mechanics.

With the help of these relations, it is possible to evaluate the commutation relations for any two functions, *f* and *g*, say, of the generalized coordinates and momenta. If *f* and *g* are expressible as power series of the q_i and p_i, then the commutation relations can be found by repeated application of those for the q_i and p_i themselves. Even in a more general case, where such power expansions are not possible, the commutation relations can be evaluated.

The classical expressions for the dynamical variables (as functions of the q_i, p_i) are simply transferred to quantum theory, where the q_i, p_i are now noncommuting quantities. This applies specifically to the Hamilton function (Hamiltonian). A system in quantum mechanics always has a Hamiltonian, whether it is one that has a classical analogue or not. If it does have a classical analogue, then the connection with classical mechanics is especially close and one assumes that the quantum Hamiltonian is the same function of the generalized coordinates and momenta in the quantum theory as in the classical theory. There is a difficulty if the classical Hamiltonian involves a product of factors whose quantum analogues do not commute, but this does not happen in most of the elementary dynamical systems of importance in quantum chemistry.

Representations of the dynamical variables:

We now come to the problem of how the noncommuting variables q_i, p_i should be represented, or realized, by specific mathematical concepts. The conditions which these mathematical concepts have to fulfill are: 1) q_i, p_i should be noncommuting; 2) their commutators should have the specific values given by the fundamental quantum conditions. Two different methods of representation are available:

1) ***Representation of q_i, p_i by matrices*** (Heisenberg's realization).

The product, AB, of two matrices is in general noncommuting:

$$AB \neq BA, \text{ since } (AB)_{ij} = \sum_k A_{ik}B_{kj}, \text{ but}$$

$$(BA)_{ij} = \sum_k B_{ik}\, A_{kj}.$$

In the matrix representation, then, we seek a system of *k* matrices $Q_1, Q_2, \ldots, Q_k$ and of *k* matrices $P_1, P_2, \ldots, P_k$, which satisfy the commutation relations

$$\begin{cases} Q_mQ_n - Q_nQ_m = 0 \\ P_mP_n - P_nP_m = 0 \\ Q_mP_n - P_nQ_m = ih\delta_{mn}/2\pi \end{cases}$$

Having found these matrices, any dynamical variable can be expressed in matrix form; for example:

$$\mathbb{H} = \mathbb{H}(Q_1, Q_2, \ldots, Q_k; P_1, P_2, \ldots, P_k).$$

Here, we must be careful with regard to the order of the dynamical variables q_i, p_i, in the classical expression for H, since their quantum counterparts do not commute. This process has not been solved with complete generality, but the appropriate arrangements are known for the most important cases. In the simplest case, where the system consists of N particles with $k = 3N$ coordinates q_i, and in which the potential energy is given in the form $U = U(q_1, q_2, \ldots, q_{3N})$, there is no problem. The classical Hamiltonian is

$$H(q_1, q_2, \ldots, q_{3N}; p_1, p_2, \ldots, p_{3N}) = \sum_{i=1}^{N} \frac{p_i^2}{2m_i} + U(q_1, q_2, \ldots, q_{3N}),$$

where m_i is the mass of the i-th particle.

In order to obtain physical information from these matrices, especially from the energy-function H, which is the dominant dynamical variable in classical mechanics (Hamilton's equations of motion), we have to assert that the matrix H contains physical information in the form of the permitted energy values of the system. These values are pure (real) numbers, and we can obtain numbers from a matrix through its eigenvalues. We postulate that the eigenvalues of the matrix of H, i.e., the roots λ of the characteristic equation, (Det = determinant),

$$\text{Det}\left(\mathbb{H} - \lambda\, \mathbb{1}\right) = 0,$$

are the permitted values of the energy of the system. To find these eigenvalues, we diagonalize the matrix $\mathbb{H}(Q_1, Q_2, \ldots, Q_k; P_1, P_2, \ldots, P_k)$; the diagonal elements are the permitted values for the system's energy.

These eigenvalues must be real. On the other hand, matrices are generated by linear transformations, also called linear operators, on a vector space. In order for the eigenvalues to be real, the matrices must be Hermitian (or self-adjoint), i.e., $A_{mn} = A^*_{nm}$, and the linear transformations (operators) must themselves be Hermitian, i.e., $A = A^\dagger$, where $A^\dagger$ is the adjoint of the operator A.

Therefore, $\mathbb{H}$ in particular must be a Hermitian function of the $Q_1, Q_2, \ldots, Q_k; P_1, P_2, \ldots, P_k$ (which are themselves Hermitian). This imposes a certain restriction in the problem concerning the order of the factors, mentioned earlier, but this restriction is not sufficient to determine $\mathbb{H}(Q_1, Q_2, \ldots, Q_k; P_1, P_2, \ldots, P_k)$ uniquely from the classical Hamiltonian.

The two steps in the matrix theory are therefore the following: (1) find Hermitian matrices $Q_1, Q_2, \ldots, Q_k$; $P_1, P_2, \ldots, P_k$ satisfying the commutation rules; (2) by a suitable choice of basis, transform the Hermitian matrix $\mathbb{H}(Q_i, P_i)$ into a diagonal matrix. This step can in principle always be carried out: a Hermitian matrix can be brought to diagonal form by a transformation

$$Q_1' = S^{-1}Q_1S; \ldots, Q_k' = S^{-1}Q_kS; P_1' = S^{-1}P_1S; \ldots, P_k' = S^{-1}P_kS,$$

with S a certain matrix possessing an inverse, S^{-1}. Fortunately, this transformation does not destroy the commutation rules for the Q_s' and P_s' since

$$Q_m'Q_n' - Q_n'Q_m' = S^{-1}Q_mS\,S^{-1}Q_nS - S^{-1}Q_nS\,S^{-1}Q_mS = S^{-1}(Q_mQ_n - Q_nQ_m)S = 0; \text{ etc.}$$

Now suppose that we have found this transformation which diagonalizes the matrix $\mathbb{H}$. Then we can compute the matrix of any dynamical variable in this basis. Some of these matrices will be diagonal, and the rest will not be diagonal in this basis. What is the physical implication of this phenomenon? We postulate that those dynamical variables which can be brought to diagonal form simultaneously with H, are ***simultaneously measurable*** with the energy. We conclude that it is never possible to diagonalize the P_s' and Q_s' simultaneously, since diagonal matrices commute; therefore, from our postulate, we know that impulse and position (of a particle) are not simultaneously measurable with unlimited precision; this leads to the Heisenberg uncertainty principle.

As was stated before, we can, instead of discussing matrices, consider the corresponding operators and a corresponding basis (a complete, linearly independent set of basis vectors) in a general vector space. Let the operator be symbolized by A, the basis by $X = \{x_1, x_2, \ldots, x_n\}$, the vector space by V. Then the matrix, [A], of the linear transformation A is generated through:

$$Ax_j = \sum_{i=1}^{N} A_{ij}x_i \ ; \ i = 1, 2, \ldots, n.$$

If the matrix [A] is diagonal, then its off-diagonal components are zero and the generating equation reads:

$$Ax_j' = A_{jj}x_j' \ ; \ j = 1, 2, \ldots, n.$$

The diagonalization is, for Hermitian matrices, carried out by a change of basis, from $X = \{x_1, x_2, \ldots, x_n\}$ to $X' = \{x_1', x_2', \ldots, x_n'\}$. The above generating equation (we omit the primes) reads in vector form:

$$Ax = \lambda x,$$

where λ is a (real) number.

In general, when we take an arbitrary vector out of our space, then a linear transformation will change both its "length" and its "direction". What we do, to solve the equation $Ax = \lambda x$, is to look for those vectors in V which, when transformed by the operator A, are the same vectors multiplied by just a (real) number. The equation $Ax = \lambda x$ is called an eigenvalue equation, λ is an eigenvalue of A, and $x(\neq 0)$ is the corresponding eigenvector.

A more detailed mathematical analysis would show that this is necessarily a problem of infinite matrices and, therewith, of infinite-dimensional vector spaces. In addition, the elements of the matrices do not have to be real, but only Hermitian, in order for the eigenvalues to be real. In general, therefore, we will operate with infinite dimensional, complex, vector spaces.

Further, the notions of "lengths" and "directions" of vectors, as generalized to complex spaces, are also a part of our mathematical apparatus. It can be shown that the scalar product (inner product) of two vectors in real spaces must then be generalized to a so-called ***Hermitian scalar product***, in symbols: (x, y), with, among others, the property

$$(x, y) = (y, x)^*.$$

Vector spaces in which such a product is defined, are called ***unitary spaces***. We need one more property: the space should be complete. An infinite dimensional, complete unitary space is called a ***Hilbert space***. The "manipulation" process is therefore carried through on the basis of the theory of linear transformations (operators) on a Hilbert space.

The condition is further imposed that vectors in a Hilbert space are of finite length. Now, if $X = \{x_1, x_2, \ldots, x_n\}$ is a basis in Hilbert space, and $\{\xi_1, \xi_2, \ldots, \xi_n\}$ any set of complex numbers, then there is a vector x in Hilbert space such that $x = \sum_i \xi_i x_i$; let also $y = \sum_i \eta_i x_i$ be such a vector. A form for the inner product (x, y) which satisfies all requirements is

$$(x, y) = \sum_i \xi_i^* \eta_i;$$

the length, $\|x\|$, of x is then defined as

$$(x, x) = \|x\|^2 = \sum_i \xi_i^* \xi_i = \sum_i |\xi_i|^2; \ \|x\| = +\sqrt{(x, x)} \geq 0.$$

We require that $\|x\|^2$ be always finite, and, excluding the trivial case of all $\xi_i = 0$, we may normalize, $\|x\|^2 = 1$, for all x.

The formalism applies physically to systems which are in stationary states (stationary Bohr orbits). This does, however, not mean that the linear transformations (operators) are time-independent. We know that $\dot{H} = 0$, i.e., the energy of the system does not

*meaning: take the complex conjugate.

change with time. What other operators are time-independent?

To answer this question, we take over the classical analogue for the time dependence, $\dot{F}$, of a function $F(q_i, p_i)$ of the generalized momenta and coordinates:

$$\text{(classical):} \qquad \dot{F} = [F, H]_{PB} .$$

Now we assume again that (PB)$\rightarrow \frac{2\pi i}{h} \times$ (commutator); thus, for any operator F:

$$\text{(quantum):} \qquad \dot{F} = \tfrac{2\pi i}{h} [F, H]_- = \tfrac{2\pi i}{h} (FH - HF).$$

This expression gives the time-dependence of any operator F. The solution is:

$$F(t) = e^{-\frac{2\pi i H t}{h}} F(0)\, e^{+\frac{2\pi i H t}{h}} .$$

It is obvious that, if F commutes with H, then we have $F(t) = F(0)$, therefore $\dot{F} = 0$.

We have represented q_i, p_i by matrices. A different representation is obtained as follows (Schroedinger):

2) Representation of q_i, p_i by differential operators.

Thereby, we have to satisfy the commutation rules. This can be done in two ways:

a) $p_k \rightarrow p_k$; $q_k \rightarrow \frac{ih}{2\pi} \frac{\partial}{\partial p_k}$ (momentum representation)

since then

$$\frac{ih}{2\pi} \frac{\partial}{\partial p_k} p_k - \frac{ih}{2\pi} p_k \frac{\partial}{\partial p_k} = \frac{ih}{2\pi} \left[1 + p_k \frac{\partial}{\partial p_k} - p_k \frac{\partial}{\partial p_k} \right] = \frac{ih}{2\pi} ; \text{ etc.}$$

b) $p_k \rightarrow \frac{h}{2\pi i} \frac{\partial}{\partial q_k}$; $q_k \rightarrow q_k$ (q-representation)

since then

$$\frac{h}{2\pi i} q_k \frac{\partial}{\partial q_k} - \frac{h}{2\pi i} \frac{\partial}{\partial q_k} q_k = \frac{h}{2\pi i} \left[q_k \frac{\partial}{\partial q_k} - 1 - q_k \frac{\partial}{\partial q_k} \right] =$$

$$- \frac{h}{2\pi i} = + \frac{ih}{2\pi} ; \text{ etc.}$$

With either of the two prescriptions we can construct the differential operator analogue of any classical dynamical variable. For example, with (b):

$$H = \sum_{i=1}^{N} \frac{p_i^2}{2m} + U(q_1, q_2, \ldots, q_{3N})$$

becomes

$$H = - \frac{h^2}{8\pi^2 m} \sum_{i=1}^{N} \left(\frac{\partial^2}{\partial x_i^2} + \frac{\partial^2}{\partial y_i^2} + \frac{\partial^2}{\partial z_i^2} \right) + U(q_1, q_2, \ldots, q_{3N})$$

$$= - \frac{h^2}{8\pi^2 m} \sum_{i=1}^{N} \Delta_i + U(q_1, q_2, \ldots, q_{3N}):$$

$$\Delta_i = \frac{\partial^2}{\partial x_i^2} + \frac{\partial^2}{\partial y_i^2} + \frac{\partial^2}{\partial z_i^2},$$

for a system of N particles in a potential field U. It is in general much easier to use the substitution (b), i.e. $q \rightarrow q$, $p \rightarrow \frac{h}{2\pi i} \frac{\partial}{\partial q}$, than (a), since most dynamical variables are given in terms of powers of p, but are rather complicated functions of q, so that we prefer to leave the q and to change the p into their differential counterparts in quantum mechanics.

By this method, we obtain dynamical variables in terms of differential operators. In order to extract physical information from these differential operators, they have to operate on "something" to produce numbers. Thus, we define a so-called wave function, $\Psi = \Psi(q_1, \ldots, q_{3N}; t)$, and write, in particular for the energy-operator:
(Schroedinger equation)

$$H \left(\frac{\partial}{\partial q_1}, \ldots, \frac{\partial}{\partial q_{3N}} \right) \Psi(q_1, \ldots, q_{3N}; t) =$$

$$\lambda \Psi(q_1, \ldots, q_{3N}; t).$$

These λ's are the eigenvalues of the differential equation $H\Psi = \lambda\Psi$ in the configuration space of the system (and not in general phase space, since the p_i do not enter in Ψ).

This differential equation (the "wave equation") has the character of an eigenvalue problem in which λ is to be interpreted as an eigenvalue parameter, and in which the vanishing of the eigenfunction at the boundaries of configuration space—together with the conditions of regularity and single-valuedness—is required. In the sense of the wave theory, the λ are the allowed energy levels (both discrete and continuous spectra).

For simplicity we do not consider the possible dependence of Ψ on the time t (i.e. we vary the q_i, but keep t constant). Let us consider the whole class of complex functions $f(q_1, q_2, \ldots, q_k)$; these functions will be abbreviated by $f(q)$, $g(q)$, . . . , since we might as well consider only one variable q. One can add two such functions, $f(q) + g(q)$, multiply them with complex numbers, etc. In fact, we can treat them in precisely the same way as general complex vectors. All possible complex functions $f(q)$, $g(q)$, . . . , form indeed a vector space. We can also define a Hermitian scalar product which satisfies all the requirements, by

$$(f,g) = \int f^*(q)\, g(q)\, dq,$$

integrated over q-space, which has, among others, indeed the property that $(f,g) = (g,f)^*$. The "length", $\|f\|$, of a vector f is then again given by

$$\|f\|^2 = (f,f) = \int f^*(q)\, f(q)\, dq;\ \|f\| = +\sqrt{(f,f)} \geqq 0.$$

These vectors form an infinite dimensional vector space, since arbitrarily many of these functions f(q) form a linearly independent set. As in the matrix representation, we require that (f,f) be always finite. We can then normalize: $\|f\| = 1$.

There is a deep-going analogy between the vector space of all $x = \{\xi_1, \xi_2, \ldots,\}$ with finite (x, x), and the space of all functions f(q), with finite (f, f); these two vector spaces are isomorphic. This is the main assertion of the so-called Fischer-Riesz theorem (1907)[4, 5].

We mean the following: one can set up a one-to-one correspondence between the two spaces, such that to each $x = \{\xi_1, \xi_2, \ldots\}$ with finite (x, x), a function f(q) with finite (f, f) is assigned and conversely, in such a manner that this correspondence is linear and isometric. Linear means: if x corresponds to f, and y corresponds to g, then αx corresponds to αf, βy to βg, and $\alpha x + \beta y$ to $\alpha f + \beta g$. Isometric ("having the same length") means: if $x \longleftrightarrow f$, then (x, x) = (f, f) and, more generally: (x, y) = (f, g).

The two spaces realize the same abstract properties in different mathematical forms. In the matrix form of quantum mechanics we study the effect of the linear transformations (operators) on the vectors x. In the wave formalism, we investigate the effect of differential operators on the functions f. The linear transformations and the differential operators satisfy the same commutation rules, whereas the two vector spaces are isomorphic. *Therefore, the matrix theory and the wave theory must always yield the same numerica results.*

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[4] E. Fischer: *Comptes Rendus de l'Académie des Sciences*, Paris, *144*, 1022 (1907).

[5] F. Riesz: *Göttinger Nachrichten* (1907), p. 116. See also W. H. and G. C. Young, *Quarterly Journal of Mathematics*, *44*, 49 (1912–1913), for a historical account and a variety of proofs.

SCIENTISTS—HIGH PRIESTS OF NATURAL PHILOSOPHY

"It is obvious . . . that during recent decades science has improved the lot of man on earth even more successfully than Francis Bacon had anticipated. It is equally true, however, that for many centuries before the modern era, science had enriched mankind with a wealth of understanding at least as valuable as material riches. Scientists, like other men, win esteem and contribute to happiness more effectively through the exercise of wisdom than through the practice of power. And it is good for them to remember that long before they had achieved technological mastery over nature and thus had become servants of society, their functions as high priests of natural philosophy had given them ancient titles of nobility which they must continue to honor."

René Dubos, in his George Sarton Memorial Lecture.

NOTES from BATTELLE

✱ METALS EXTRUSION PROCESS

A research license has been granted Battelle for the patented Ugine-Sejournet steel extrusion process, which uses molten glass as the extrusion lubricant. Under the terms of a recently concluded agreement with Compagnie du Filages des Metaux et des Joints Curty, the Institute will use the process to conduct research for industry and government on various extrusion applications.

In the Ugine-Sejournet process a doughnut-shaped glass disc is placed in the extrusion container between the hot billet and the cold die. As the extrusion press ram moves the billet against the disc, a thin layer of glass melts and adheres to the billet. Thus, the metal passing through the die opening is continuously coated with a thin lubricating film of glass. At the same time, the unmelted glass insulates the tools from the hot billet. The whole operation is performed in only a few seconds.

"The glass-lubricated extrusion process," says Battelle's Alvin M. Sabroff, "makes it possible to extrude metals at temperatures far beyond the temperature limitations of conventional extrusion equipment. In addition to its importance for the steel-extrusion industry, the process also opens up whole new areas of extrusion of high-temperature metals such as superalloys, columbium, molybdenum, tantalum, and tungsten. Through the use of glass lubricants, successful extrusion of molybdenum and tungsten alloys has been recently achieved at temperatures greater than 4000 F."

According to Paul D. Frost, of Battelle's metals-economics staff, the steel extrusion industry in the United States has just begun to develop its markets. "Continued research with the Ugine-Sejournet process should make it possible to extrude longer, thinner, and more complex steel sections. The availability of a wider variety of shapes could extend the use of steel extrusions in many fields—automotive, agricultural machinery, electrical equipment, home appliances, and architectural materials, as well as for military and space applications".

✱ METALS-BONDING MECHANISMS

Bonding metals by means of gas pressure at high temperature is a relatively new joining process. It is especially useful because it enables such joining with little deformation. As yet, most knowledge about the process is empirical, and little is known about the mechanism of pressure bonding.

Some new conclusions about the mechanism, an outgrowth of recent studies on copper, have been reported by George W. Cunningham of Battelle and Professor J. W. Spretnak, of Ohio State University. They state that:

- By providing sufficient excess strain and interfacial energy, it is possible to form a continuous grain structure between metal faces in the bond region, with no detectable residual interface.
- There is good evidence to indicate that interfacial voids are the principal cause of limited grain-boundary migration in the bonding region.
- If interfacial voids exist in the bond region, recrystallization, growth of small grains, or an allotropic transformation may provide the energy required to promote grain growth there.
- Grain growth in the bond region is more likely if the activation energy for such growth is low when the interface is created. Pressing at a high temperature is more effective than pressing at a low temperature and then heating the interface under pressure; an exception — when pressure is applied before heating the interface through a recrystallization or an allotropic transformation range. The research on bonding mechanisms was conducted at Battelle for the Division of Reactor Development of the U.S. Atomic Energy Commission.

✱ NUCLEAR TO ELECTRICAL ENERGY

Getting electricity directly from the atom has been a long-sought goal of scientists. A means for accomplishing it now appears attainable. Through a concept known as the Triode Converter, created by members of Battelle's physics department, it is possible to convert the kinetic energy of the highly charged fragments from nuclear fission directly into electrical energy. The study, initiated at the Institute, is continuing under sponsorship of Pratt & Whitney Aircraft Company, a division of United Aircraft Corporation.

According to Sherwood L. Fawcett, James N. Anno,

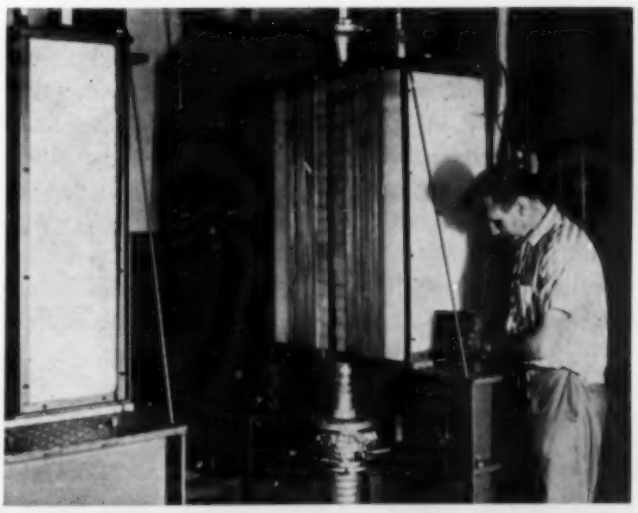
Jr., and their colleagues, the following are the key problems and the steps by which they are being attacked. First, ways must be found to enable fragments to escape when uranium fissions under bombardment by neutrons. Fission of U-235 results in two types of positively charged fission fragments, whose movements (kinetic energy) represent about 84 per cent of the total energy released. Distributing uranium in very thin layers (a few microns thick) allows the escape of a large fraction of the fission fragments from its surface. When collected on a properly insulated electrode placed near the uranium, these fragments can cause a buildup of voltages to several million volts.

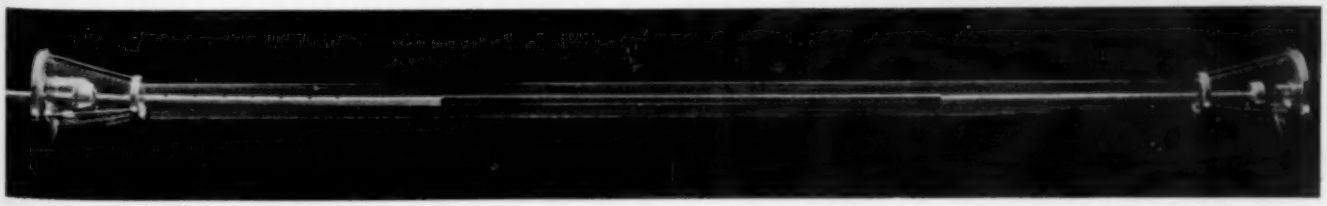
A second problem is created by the secondary electrons (having negative charges) which are produced in such amounts as to offset the positive charge of the fission fragments. The triode, mentioned above, contains a grid designed to repel these secondary electrons while admitting positively charged fragments, thus making an electrical current possible. Much of the study has been devoted to determining the nature of the charged particles present in the triode and learning how to control them. In recent experiments, Battelle technologists have succeeded in creating small currents.

In order to have an easily controlled source of neutrons, Battelle technologists developed the Battelle Plastic Reactor Facility. It is constructed in the form of a cube and is composed of strips of aluminum and uranium sandwiched with plastic and encased in aluminum boxes. The central portion of the reactor is a void region where experiments are conducted under vacuum. Operating at levels to 200 watts, the core is built in sections on two tables, one movable. Separation of the tables, and the core halves, provides convenient access to the reactor.

The study of the energy conversion concept was begun in 1958, and it has included many in-pile experiments at the Battelle Research Reactor. Experiments are continuing in both reactors—those requiring high radiation levels in the research reactor; those calling for unusual combinations of radiation, high vacuum, and special equipment, in the plastic reactor.

BATTELLE STAFF MEMBERS recently named to technical posts include • *Richard B. Engdahl*—vice chairman, Committee on Research in Small Colleges, American Association for the Advancement of Science • *Robert B. Filbert, Jr.*—chairman, Symposium on High Temperature, Properties and Application of Liquid Metals, American Institute of Chemical Engineers • *Fred W. Fink*—co-chairman, Corrosion in the Missile Industry Symposium, National Association of Chemical Engineers • *Richard L. Gibbs*—membership chairman, District 5, Instrument Society of America • *Bruce W. Gonser*—chairman, Lecture Committee, Extractive Metals Division, American Institute of Mining, Metallurgical and Petroleum Engineers, also, member, Board of Directors, American Society for Testing Materials • *J. Harry Jackson*—member, Administrative Committee on Research, American Society for Testing Materials • *Clarence H. Lorig*—member, Committee on Advancement in Research Award, also, member, Foundation for Education and Research, American Society for Metals • *Theodore S. Shilliday*—chairman, Task Force on Thermoelectric Materials, ASTM • *Frank M. Stephens, Jr.*—member, Program Committee, Minerals Beneficiation Division, AIME.





Below. *A typical triode (grid-cathode assembly) used in research on the direct conversion of nuclear to electrical energy.* Right. *The Battelle Plastic Reactor developed for the conversion studies. The triode can be seen in place in the center of the core to the right.*

Some Aspects of Superconductivity

The author reviews the growing knowledge of superconductivity and discusses the attractive possibilities for useful applications of the phenomenon.

by WILLIAM B. GAGER

IN 1908 THE FIRST LIQUEFACTION of helium opened to scientists the temperature range from 4.2 K down to 1 K. Thus materials could be examined at temperatures approaching absolute zero. One immediate problem facing the physicist interested in solid-state problems was whether the electrical resistance of metals continued its approach to the value zero as the temperature fell lower and lower. The examination of the resistance of mercury, to answer this question, uncovered a very surprising anomaly. The resistance dropped to zero, as far as the instruments could detect, at a temperature of 4.2 K. Further, this unexpected drop from the estimated value took place over a range of temperature of only five hundredths of a degree. Thus the phenomenon now known as superconductivity was discovered; a phenomenon which has been both interesting and perplexing to researchers ever since and is only now beginning to be understood.

Since that first discovery, many elements, alloys and compounds have been examined to see whether they also show this behavior. While many do, the very good conductors at room temperature—silver, gold, and the alkali metals—do not. The adjoining table lists the elements that have been identified as superconductors. In recent years, much effort has been expended in the investigation of superconductivity, and a number of interesting applications have been developed. Among these are thermal switches, frictionless bearings, current switches, and diode-like switches.

THE NATURE OF SUPERCONDUCTIVITY

The immediate experimental fact to be noted about a superconducting material is the sudden disappearance of electrical resistance—the fact which gives the phenomenon its name. As has been mentioned, this loss of resistance takes place over a narrow range of temperature (graph on page 14). The range is dependent upon the material, its purity, and its state of physical strain.

Electrical Resistance

The question immediately arises as to whether one actually has a zero resistance or some finite value too small to detect by the available potentiometers. A technique employed to answer this question is based on a resistive-inductive circuit. A single loop of wire is made from a superconducting material and cooled to a temperature below its transition point. By a change of magnetic field, a current is induced in this loop. With a continuous electric current in a closed loop, one has essentially a magnet whose strength is determined by the value of the current. Therefore, a measurement of the magnetic field of this loop measures the current. Should the wire have any finite resistance, the current will decay; the lower the resist-

SUPERCONDUCTING ELEMENTS AND THEIR TRANSITION TEMPERATURES

Elements[1]	T_c °K	Elements[1]	T_c °K
Al	1.14	La	4.71
Ti	0.53	Hf	0.35
V	5.1	Ta	4.38
Zn	0.79	Re	2.4
Ga	1.07	Os	0.71
Zr	0.7	Hg	4.15
Nb	9.22	Tl	2.38
Tc	11.2	Pb	7.22
Ru	0.47	Bi[3]	
Cd	0.54	Th	1.32
In	3.37	U	0.8
Sn[2]	3.73		

1. In the order of their atomic numbers.
2. White tin only.
3. Only as amorphous film or under high pressure.

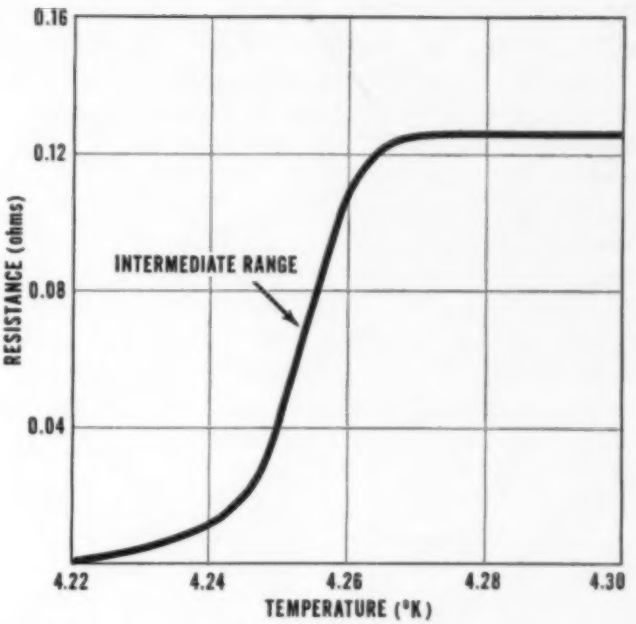
ance the longer it will take to decay. One experiment at the Massachusetts Institute of Technology, where a current of several hundred amperes was induced in a superconducting loop, showed no decrease in current over a period of two and one-half years, which provides the most positive evidence that the resistance is actually zero in a superconductor.

Absence of electrical resistance would seem to be a great boon to the engineer desiring to transmit large currents over great distances. But there is a catch to this picture; it involves the "critical current", the value of current above which superconductivity is lost and the metal reverts to its normal resistive state. This results because the current generates a magnetic field which destroys the superconducting state.

It will be seen from the graph on page 16 that a magnetic field produces a decrease in the critical temperature or transition point. The curves of critical field versus transition temperature have been plotted for five different elements. Niobium exhibits the highest critical field, a value of 2500 gauss as the temperature approaches absolute zero, while of the elements plotted, tin shows the lowest, 300 gauss. These curves are for pure elements. In recent years, alloys and intermetallic compounds have been made which show not only much higher maximum critical fields but steeper slopes.

Magnetic Properties

During the earlier years of experimentation with superconductivity, it was assumed that the magnetic properties could be explained adequately by the zero-resistance criterion. In 1933, however, Meissner and Ochsenfeld discovered that this was not true. Electromagnetic theory states that for a material of zero resistance the time rate of change of a magnetic field inside a specimen should be zero. This means that if initially a magnetic field existed inside a sample, then the transition to zero resistance followed by a decrease of applied magnetic field should leave the internal magnetic field unchanged. If initially a field did not exist, but was applied after the sample had gone into a state of zero resistance, then the field could not penetrate, and the interior magnetic field would be zero. The discovery of Meissner and Ochsenfeld consisted of showing that not only was the time rate of magnetic field inside the superconductor zero, but that the interior magnetic field itself was always zero. Only by applying a magnetic field strong enough to destroy superconductivity could they force a field to penetrate the sample. Subsequent experiments have shown that this effect is a property of superconductivity and not merely due to the geometry of the samples used.



Graph by Onnes (1911) to show intermediate range wherein mercury loses most of its resistance. Modern instruments show that mercury becomes superconductive at 4.15 K.

This nonpenetration effect, now called the Meissner effect, is at present considered to be one of the major criteria for determining the presence of superconductivity. Any theory must make a conscious effort to explain the Meissner effect. Also, many of the present applications of superconductivity rely entirely upon this effect and not upon the zero-resistance property.

The expulsion of the magnetic field is not entirely complete since, as the field is pushed further and further toward the specimen's edges, it becomes intensified and finally the critical field is reached at the edge of the sample. A penetration depth of about one-ten thousandth of a centimeter is common for simple geometrical shapes. For very intricate shapes, greater penetration can often be achieved. This penetration changes character as the field is increased toward the critical value. In the intermediate state, that is during the transition from the superconducting to the normal state, domains of alternating normal and superconducting material frequently lie adjacent to each other, very much in the manner of magnetic domains in ferromagnetic material.

Thermal Properties

A measurement of the thermal properties of superconducting materials shows an interesting effect. While there is a specific heat change as materials go from the normal to the superconductive state, it has been shown that when there is no applied magnetic field, there is no latent heat. If a magnetic field is applied, however, a latent heat may be measured.

Scientists have noted, too, that the electrons responsible for superconductivity do not carry thermal energy. Thus, when the thermal conductivity is measured, a break is found at the transition temperature, after which the conductivity falls very rapidly. If the material is maintained in the normal state by the application of a magnetic field, this break does not occur and the conductivity remains high, only slowly dropping as the temperature is lowered. For lead at 1 K, the thermal conductivity of the normal state is about one thousand times greater than it is in the superconducting state. This has been used in experiments as a thermal switch. Two specimens at different temperatures are joined by a piece of lead. A magnetic field is applied to the lead and heat then flows. Removal of the field again insulates one sample from the other. Design of these units requires care in material selection since some alloys and intermetallic compounds show an increase of thermal resistance below the transition temperature.

Superconductivity Theory

Theories to explain this phenomenon have been slow in developing. A few years ago, however, Bardeen, Cooper, and Schrieffer, working at the University of Illinois, presented a theory which seems to explain such basic experimental facts of the situation as critical temperature, critical magnetic field, and Meissner effect. They were led to their theory by the so-called isotope effect. This effect is present when different isotopes predominate in each of two specimens, tin for example, in which the specimen having the more massive isotope will have the lower transition temperature. Working from this phenomenon, the scientists theorized that pairs of conduction electrons are coupled by means of lattice vibrations, only electrons so coupled taking part in superconductivity.

The theory also proposes that this coupling gives rise to an energy gap between the normal and superconductive states and that this energy gap should be detectable experimentally. Experiments designed to study specific heats, infrared spectra, and electron tunneling in materials below the superconducting transition temperature have shown positive evidence of this structure.

Potential Applications

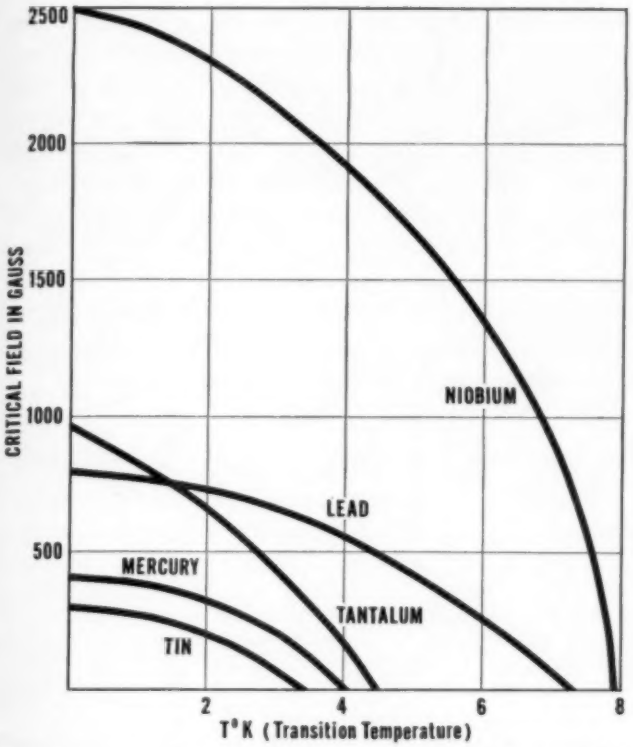
During the past few years, research laboratories interested in producing new devices and applying new techniques to older devices have been looking more and more toward superconductivity. Since the temperatures involved are very low, only a few degrees above absolute zero, the inherent thermal noise should be very low. This fact is very attractive to circuit-element designers. Such devices as thermal switches, frictionless bearings, small frictionless gyroscopes, on-off switches, tunneling switches, and others have been designed and tested on a laboratory scale. While these devices have not yet emerged from the laboratory, work is progressing. Let us now look into how some of these devices function.

Basis of Frictionless Applications

The use of superconductivity to produce such items as frictionless bearings leans heavily upon the Meissner effect to achieve repulsive forces. To illustrate the basis for these devices let us first consider a simple demonstration experiment. A small bar magnet and a dish made of tin are placed in a Dewar flask with the magnet lying inside the dish. This apparatus is now cooled to 4.2 K by adding liquid helium. The transition temperature of tin is 3.73 K so that initially the demonstration is above the superconducting state with the field from the bar magnet penetrating the tin. The magnet lies in the dish. If now the temperature is decreased by lowering the vapor pressure of the liquid helium, it is discovered that below 3.73 K the bar magnet begins to rise off the dish and float above it.

This bit of witchcraft is relatively easily explained if we recall our criteria of perfect diamagnetism. The magnetic field created by the bar magnet initially penetrates the dish, but after the dish becomes superconducting, the magnetic field is pushed out of the dish, and the reaction forces thus set up cause the magnet to float. Physics tells us that the diamagnetic susceptibilities are negative and thus diamagnetic materials are forced out of a magnetic field. It is this effect, in its extreme form, that is operating here.

Dr. Gager has been conducting research at Battelle on electron spin resonance and nuclear magnetic resonance in solids, particularly in semiconductors and metals. One of his concerns has been the investigation of materials for use in the preparation of masers. Earlier, at the Bureau of Standards, he conducted studies on electron spin resonance at low temperatures. Gager's interest in superconductivity problems grew out of his participation at Ohio State University, in studies of superconducting transition temperatures and critical-field dependence, at temperatures below 1 K.



The decrease in critical temperatures of several elements that results from application of a magnetic field.

Frictionless Devices

The above effect is the basis of a frictionless magnetic bearing. Imagine a disk of superconducting material resting upon a flat pancake coil. When a current is passed through this coil, a field is created which will support the disk and a limited load so long as this field is below the critical value. It should be obvious that the only frictional forces that can arise will be those caused by the viscosity of the liquid helium refrigerant or, if the system is in a vacuum chamber where no viscous resistance is present, there is no friction because no parts are in contact. This technique has also been modified for sleeve bearings, where the shaft is surrounded by a ring of superconducting material, this ring rotating with the shaft. The fixed part of the bearing is a coil.

The frictionless advantage produced by the diamagnetic effect for bearings is also useful in the production of fine gyroscopes. With the gyroscope being rotated by an alternating field, the frictionless properties should allow good, long-time stability.

Electromagnets

Superconductivity is now being used in producing electromagnets of very high magnetic-field strengths. As mentioned previously, there exists a certain field strength above which the superconductor becomes normal and a critical current value above which superconductivity is destroyed. These two effects are now believed to be one and the same, that is, the current is producing at the specimen a critical magnetic field. It is this effect that makes the production of superconducting magnets a problem.

Workers at the Bell Telephone Laboratories have recently been able to achieve superconducting solenoids of 15 kilogauss field strength. To do this they used an alloy of nominal composition, Mo_3Re, made into a wire and then wound as a coil. Experiments upon a compound, Nb_3Sn, have shown that at 2 K the material can carry appreciable currents in steady magnetic fields of 88 kilogauss, and under pulsed conditions the field can go as high as 180 kilogauss before superconductivity is destroyed. Due to the brittleness of this compound, fabrication problems are extremely difficult; but the interest in the possibility of very high-field superconducting magnets induced by the properties of this alloy, has encouraged efforts to develop other compounds and alloy systems.

Switching Devices

The control of electrical current through superconducting wire by means of a magnetic field that switches the wire from the superconducting to the normal state has permitted the development of several on-off switching devices. These devices are now being studied for their use in computer applications. Their main drawback is their long-time constant. Modifications employing thin-film technique are now under developmental study with the hope that the switching times may be shortened to milli-microseconds.

Perhaps of more importance to switching applications has been the development of a tunnel type of device, which is constructed of two thin layers of superconducting material separated by an insulating layer, all deposited on an insulating base. Scientists have found that under certain conditions electrons from metal can tunnel through the insulator into the second metal. The device has many of the characteristics of the tunnel diodes and may have greater usefulness in such applications.

The devices discussed are still in the laboratory development stage, and much research is needed before production models are available. Indeed, the effort being expended upon them is at a less intensive rate than the research on semiconductors or the more esoteric masers. A great deal of the current experimental work in superconductivity is directed to the examination of intermetallic compounds, alloy systems, solid solutions, and the like. As this study continues, scientists are likely to find materials enabling device engineers to improve and extend their creations into new and better applications.

TOWARD A POLICY FOR SCIENTIFIC PROGRESS

"In the advancement of science the best is vastly more important than the next best."

— President's Science Advisory Committee

A MAJOR POLICY DOCUMENT recently released by the National Science Foundation shows that:

- Scientific talent is a scarce resource that the United States must develop fully to secure its future well being;
- Steadily increasing numbers of talented young people want to become scientists;
- If this trend is maintained we will have twice as many scientists in 1970 as we have now;
- To maintain this trend will require sharply increased dollar investments in science education and basic research in colleges and universities.

The report, *Investing in Scientific Progress*, analyzes science education trends over the past 40 years and projects these trends to 1970. The major thesis stated by the report is: "Every young person who shows the desire and the capacity to become a scientist should be ensured the opportunity to do so."

During fiscal year 1961 the United States invested from all sources a total of $3 billion in colleges and universities for science and engineering education and for basic research, the report notes. This investment must grow to at least $8.2 billion in fiscal year 1970 to achieve the goal.

The report notes that while U.S. population is expected to grow by 20 million from 1960 to 1970—reaching a total of 200 million persons—the total world population during that decade is expected to grow by 420 million. Population of the earth in 1970 will be 3,330 million. Since the United States cannot hope to compete in terms of sheer numbers of scientists and engineers, we must concentrate on quality within the possibilities of our population.

Will fulfilling the nation's science potential handicap the other professions by draining off too much of the nation's top talent? By no means, the report says. "Of all 'doctoral age' young people who score in the top 1 per cent on intelligence tests," it says, "fewer than one in twenty now get doctorates in science and engineering." The proposed doubling of science and engineering doctorates would still leave a wide margin of capacity for intellectual leadership in all professions.

Moreover, of all young people in the U.S. who reach college graduating age each year, the per cent who get college degrees is doubling every 18 years. This trend shows there is a steadily growing desire for a college education. "Because the rate of increase has been stable for many years, and because intellectual incentives are on the rise, the established trend is expected to continue during the next ten years."

The NSF document points out that:

- The Nation's total annual expenditure for science and engineering education and for basic and applied research is about $10 billion, or only about 2% of the $505 billion Gross National Product.
- Colleges and universities now have a deficit of about $300 million worth of science teaching equipment. Beyond the need to make up this deficit, they will require an average of about $200 million annually for the next ten years to take care of growing demands.
- Colleges and universities now have a deficit of about $500 million worth of science laboratory buildings. Beyond the need to make up this deficit, they will require annually increasing funds up to $360 million in 1970 to take care of growing demands.
- Colleges and universities will require annual investments of up to $180 million in 1970 for adequate research equipment for science laboratories.

The report also shows that the per cent of the "doctoral age group" earning doctorates in science and engineering has been doubling every 12 years. In 1960, 6,600 such degrees were granted, and there will be a potential 13,000 in 1970.

The Foundation proposes that national investment in basic research in colleges and universities during the decade must increase — from 45,000 (1961) to 85,000 (1970) in professional research scientists; from $345 million to $970 million in salaries for these scientists; from $85 million to $360 million in facilities for this staff; from a total expenditure of $.9 billion for basic research to an expenditure of about $2.7 billion.

In its discussion of concepts, goals and projections the report states: "Clearly our nation will need its full share of scientific talent. But only through superior quality — not sheer number — of our scientists can we maintain effective leadership in helping other nations as well as ourselves to achieve the great cultural and practical values of this scientific era."

Writings by STAFF Members

Research Reactor Services. Describes construction, operation and operating costs of the Battelle Research Reactor. Compares fuel reprocessing costs with other operating costs. ***J. N. Anno.*** Paper from *Institute of Nuclear Materials Management. First Annual Meeting*, June 29-21, 1960, pp. 15-28, Institute of Nuclear Materials Management, Pittsburgh.

Plastic Working. Reviews the literature on forging, rolling, sheet forming, and extrusion. ***Francis W. Boulger.*** *Mechanical Engineering*, v. 83, June 1961, pp. 55-57.

Review of Current Data on the Tensile Properties of Metals at Very Low Temperatures. *J. E. Campbell.* PB 151107; Battelle Memorial Institute, Defense Metals Information Center, *DMIC Report No. 148*, Feb. 14, 1961, 79 pp. (OTS $2.00)

Start a Reliability Campaign. Suggests the addition of a reliability group to cost, performance, and styling production requirement committees. ***Hall Cary.*** *SAE Journal*, v. 69, June 1961, pp. 65-67.

Planning Automated Assembly. In the analysis of assembly operations for the purpose of considering automated production steps, many influences deserve careful evaluation. The author discusses factors such as market outlook, standard-special product mix verification of technical feasibility, quality, and handling costs. ***H. C. Davis.*** *Automation*, v. 8, March, 1961, pp. 54-57.

Prevention of Low-Load Smoke From Spreader Stokers. Spreader-stoker design has a bearing on control of low-load smoke. A major objective of boiler-stoker design should be to control oxygen-fuel ratio. Of even greater importance is plant maintenance to keep air leakage under control. Of greatest importance is operator skill. Management has a part to play on each of these points. If management is aware of their importance, repeatedly makes that awareness clear to the operator, and provides appropriate backing for the essential efforts, low-load smoke can be satisfactorily controlled. ***Richard B. Engdahl and Wright A. Erion.*** *Coal Utilization*, v. 15, March, 1961, pp. 15-16.

Electroplating Chromium Directly on Aluminum. A chromium-plating process is described using direct current of a nature heretofore considered unsuitable for practical plating. The electrodepositing current is related to the chromium hydride mechanism of deposition for providing relatively soft chromium of sufficiently low stress for direct deposition on aluminum. The chromium has lustrous sheen and needs color buffing only to bring it to full brillance or it can be plated with bright nickel (instead of coloring) and with the same chromium which is mirror bright over bright nickel plate. Also, the bright chromium is free from porosity and from cracks at thicknesses affording significant increase in corrosion protection as shown by corrosion in outdoor, CASS and Corrodkote exposures. ***Charles L. Faust, Glenn R. Schaer, and Donald E. Semones.*** *Plating*, v. 48, June 1961, pp. 605-612.

The Corrosion of the Inconel HF Inlet and Salt Outlet of the MK II Dissolver. Inconel has only borderline resistance to hydrofluorination conditions and must be used with caution. It appears that the corrosion rate curve for Inconel in this system rises rapidly in the temperature range 600-800 C and that rapid failure can take place if excessive temperatures are reached. ***F. W. Fink.*** U. S. Atomic Energy Commission, *TID-6215*, July, 1960, 11 pp. (LC mi $2.40, ph $3.30)

Evaluation of Two Bisphenols as Wood-Preservative Agents. When used as co-toxicants with creosote, copper naphthenate, and creosote-coal tar, two chlorinated bisphenols greatly increased effectiveness of these standard preservatives against terrestrial and marine organisms. The two bisphenols included in the present study were Compound G-4 and 2,2'-thiobis (4-chlorophenol). ***R. G. Fuller.*** *Forest Products Journal*, v. 11, April, 1961, pp. 193-196.

Effects of Nitrogen Mustard on the Histochemistry of Mouse Lymphocyic Leukaemia *L* 1210. Chemical changes occur quite rapidly in mouse leukemia cells of the *L* 1210 strain following nitrogen mustard therapy. Certain histochemically demonstrable changes were noted in the leukemic cells following nitrogen mustard and before apparent morphological alteration. The possibility of nitrogen mustard binding to available sulphydryl groups present in the leukemic cells seems likely, and may be the mechanism accounting for the decreased sulphydryl reaction given by these cells following nitrogen mustard. ***George J. Furman, G. Adolph Ackerman, and Carl Cohen.*** *Nature*, v. 189, Feb. 18, 1961, pp. 591-592.

$MoSi_2$-UO_2 Ceramics for High-Temperature Fuel Elements. The strength and oxidation resistance of densely sintered $MoSi_2$ ceramics were not seriously impaired at temperatures to 2300 F by adding up to 30 w/o of dispersed UO_2. However, the loss by volatilization in high-temperature air of small but detectable amounts of uranium might possibly limit the service temperature of $MoSi_2$-base fuel elements containing UO_2, even though the mechanical properties are not significantly damaged. Development of protective refractory coatings, or of uranium compounds more oxidation resistant than UO_2, might lead to the solution of this problem. ***J. R. Gambino, J. F. Quirk, and W. H. Duckworth.*** U. S. Atomic Energy Commission, *BMI-1029*, August 18, 1955, 30 pp. (LC mi $2.70, ph $4.80)

Preparation of Some Condensed Ring Carbazole Derivatives. Two new indolocarbazoles have been prepared by vapor phase cyclodehydrogenation of *N,N'*-diphenylphenylenediamines over a platinum-on-magnesia catalyst. This method has also been used for the preparation of benzocarbazoles from phenylnaphthylamines. ***Henry M. Grotta, Charles J. Riggle, and Arthur E. Bearse.*** *Journal of Organic Chemistry*, v. 26, May 1961, pp. 1509-1511.

Pickling and Descaling of High-Strength High-Temperatures Metals and Alloys. Brings together a partial selection of chemical and electrochemical descaling and pickling procedures that have been employed on the high-strength, high-temperature metals and alloys. ***J. A. Gurklis and L. D. McGraw.*** PB 161235; Battelle Memorial Institute, Defense Metals Information Center, *DMIC Memorandum* 85, Feb. 8, 1961, 17 pp. (OTS $0.50)

Further Results of Irradiation of Uranium Carbide. The results of the postirradiation examinations on UC compounds having nominal compositions of 4.6, 4.8, and 5.0 w/o C continue to be encouraging after irradiation to approximate burnups of from 1000 to 15,000 MWD/Ton of U. Density changes were small, varying from a minimum of 0.7% to a maximum of about

HOW TO GET COPIES OF STAFF WRITINGS

In this section are listed reports, articles, and other writings authored by Battelle staff members that have recently become generally available. • *Reports, unless otherwise indicated, can be purchased prepaid directly from the Office of Technical Services, U.S. Department of Commerce (designated OTS), Washington 25, D. C. or from the Publication Board, Library of Congress (designated LC), Washington 25, D. C. Abbreviation "mi" stands for microfilm, "ph" for photostat. The PB and AD numbers or, in the case of the U.S. Atomic Energy Commission Reports, the AEC numbers of each report must be listed with the order.* • *Federal agencies and government contractors, their subcontractors and suppliers may obtain DMIC Reports gratis from the Defense Metals Information Center, 505 King Avenue, Columbus 1, Ohio.* • *In most cases, copies of articles and papers listed in this section—but not in the Abstracts Section which follows—are available gratis from the Battelle Publications Office, 505 King Avenue, Columbus 1, Ohio.*

2.5%. The fission gas-retention properties of this material appear quite good. ***A. W. Hare, S. Alfant, and F. A. Rough.*** *Nuclear Science and Engineering*, v. 10, May 1961, pp. 24-30.

Gaging Future Mineral Demand. Discusses methods used in forecasting markets and the future of some of the exotic metals that have come to the fore in the past decade or two, including beryllium, boron, cesium, columbium, tantalum, lithium, molybdenum, rare earths, rhenium, tellurium, titanium, uranium, and zirconium. ***Richard J. Lund.*** *Canadian Mining Journal*, v. 81, April, 1960, pp. 116-120.

Precipitation Hardening of Co-Base Alloys by Means of an Intermetallic Co-Mo Phase. Concludes that coherent or partially-coherent particles with a diameter of about 50 Å are formed during the age-hardening process. It has not been possible, however, to determine whether these particles have the Co_3Mo or Co_7Mo_6 structure in the intermediate stages of precipitation. ***B. Lux and W. Bollmann.*** *Cobalt*, no. 11, June 1961, pp. 4-20.

A Statistical Summary of Mechanical-Property Data for Titanium Alloys. Describes in a series of histograms and charts some mechanical properties of several titanium alloys in various conditions and directions in terms of average values and standard deviations. The alloys described were produced and tested in the period from 1957 into 1960. The usefulness of these descriptions depends entirely on the judgement of the user in combining them with his own or any other similar data showing the effects of changed titanium production as well as changes in processing or testing techniques, on titanium-alloy strength properties and their variability. ***W. Stuart Lyman.*** PB 161237; Battelle Memorial Institute, Defense Metals Information Center, *DMIC Memorandum 87*, Feb. 14, 1961, 25 pp. (OTS $0.50)

Intrinsic-Radiotracer Process Control. A general discussion of the potential applications of intrinsic radiotracers to industrial process control is presented. This method of control consists of adding to a process stream a radiotracer in the same form as the material to be followed or controlled. Subsequent radioassay of the stream provides the information necessary for control of an operation or group of operations being performed on the process stream. The various unit operations are discussed individually, and a few specific applications of intrinsic radiotracers are suggested for each. ***James L. McFarling, Peter Gluck, John F. Kircher, and Duane N. Sunderman.*** U.S. Atomic Energy Commission, *BMI-1499*, Feb. 10, 1961, 42 pp. + appendix. (OTS $1.00)

Industrial Research. Describes basic applications of light microscopy. Covers resolving limit, useful magnification, and contrast; alignment, and related methods of illumination; and the initial necessity of correct specimen preparation. ***C. W. Melton and C. W. Schwartz.*** Paper from *The Encyclopedia of Microscopy*, pp. 363-381, 1961. Reinhold Publishing Corp., New York.

Investigation of the Fatigue Properties of Molybdenum Under Various Conditions of Temperature, Coatings, and Stress Concentration. Fatigue behavior of unalloyed arc-cast molybdenum was investigated in tension-tension fatigue loading on uncoated and coated, unnotched and notched sheet specimens at 1800 F, room temperature, and -40 F. Three oxidation-resistant coatings were evaluated under fatigue loading. Static tensile tests were also conducted on specimens of the four surface conditions at the three temperatures. ***Alexander A. Mittenbergs, Dean N. Williams, et al.*** PB 171617; U.S. Air Force, Wright Air Development Division, *WADD Technical Report 60-427*, Oct., 1960, 137 pp. (OTS $2.75)

Radiation Can Ruin Your Design. When designing for a nuclear radiation environment, it must be remembered that materials can be rendered useless in their design application by radiation-produced changes of physical properties. ***Mary Jane Oestmann, J. F. Kircher, J. W. Clark, and T. D. Hanscome.*** *SAE Journal*, v. 69, June 1961, pp. 82-84.

Mass and Heat Transfer During the Chemical Vapor Deposition of Metals. A general mathematical treatment of the mass- and heat-transfer rates in a de Boer-Van Arkel refining cell is presented. This treatment covers one of the more practical process situations wherein the change in dimensions of the deposition surface, as a result of metal deposition, significantly affects the diffusion path between the deposit and feed and the heat loss by the deposition surface. A steady-state, counter-diffusion, nonconvective system is assumed. ***J. H. Oxley and J. M. Blocher, Jr.*** *Electrochemical Society, Journal*, v. 108, May 1961, pp. 460-464.

Biological Significance of ODPN—Insoluble and Glycol-Insoluble Tests. The results of bioassay tests indicate that a quick method for determination of the relative initial preservative potential of creosote and creosote-petroleum mixtures may be available to the wood preserving industry. ODPN-insoluble test values are related to the expected unweathered block thresholds that might be obtained by soil-block bioassay. The same relationship holds for glycol-insoluble values since these have been shown to parallel the ODPN data. ***Gail Reynolds and J. E. Burch.*** *Forest Products Journal*, v. 11, April, 1961, pp, 201-202.

Need Precision? Don't Overlook Electroforming. Making a metal part by electroplating over a removable mandrel is often thought to be a costly technique. But it needn't be if you know the latest mandrel systems, plating alloys and design methods. Here's a review that brings you up to date. ***W. H. Safranek.*** *Product Engineering*, v. 32, no. 23, June 5, 1961, pp. 44-49.

How Casting Defects Affect Quality of Electroplated Zinc Die Castings. New electroplating procedures have greatly improved the durability of plated zinc die castings. The die-casting industry is now faced with the need for contributing its share toward further improvements because premature corrosion failures, coinciding with casting defects, occur on many commercial parts. Economic factors are expected to bring about improvements in the surface quality of die castings in the immediate future, however. Over-all cost savings in producing plated zinc die castings are within the reach of any plant prepared to enforce high quality standards. ***Wm. H. Safranek.*** *Technical Paper No. 12*, presented at The First National Die Casting Exposition & Congress, Detroit Artillery Armory, Nov. 8-11, 1960. Society of Die Casting Engineers, Inc., Detroit, Michigan, 12 pp.

Columbium. Describes: sources; separation of columbium from tantalum; extractive metallurgy; consolidation and purification; physical, mechanical, and chemical properties; analysis; metallography; metal working, fabrication, and cutting; cleaning; electroplating; welding; and applications. Includes a bibliography of 150 entries. ***Edwin M. Sherwood.*** Paper from *Rare Metals Handbook*, 2nd Ed. pp. 149-177. 1961. Reinhold Publishing Corp., New York.

Applications of Materials to Solid-Rocket Nozzles. The ever-increasing performance of propellants, headed for combustion temperature of 8300 F in the next decade, stimulates the drive for better nozzle materials. Advances in materials and nozzle-design technology will be necessary to use these advanced propellants. There is need for additional research on exhaust-product environments and expansion processes, on composite materials which utilize constituents more refractory than tungsten, and on improved ablation materials. ***Edward W. Unger.*** *Astronautics*, v 6, April, 1961, p. 24+6 pages.

An Economist Takes a Second Look at Factors in Chemurgy's Future. Recommends seven ideas designed to advance chemurgy. These proposals include a comprehensive inventory of chemurgic raw materials, development of a method and equipment for local processing of agricultural residues, conversion of existing surplus stocks to another form, technical-economic appraisal of existing chemurgic opportunities, an orderly and systematic review of new plant possibilities, appraisal of chemurgic research resources, and establishment of a chemurgic information center. ***Odin Wilhelmy, Jr.*** *Chemurgic Digest*, v. 20, April, 1961, pp.3-6

Recent Developments in Titanium. Survey of markets, chemical reactions, mechanical properties, status of new high-strength alloys, and fabrication of titanium. ***R. A. Wood.*** *Light Metal Age*, v. 19, April, 1961, p. 6+1 page.

BATTELLE TECHNICAL REVIEW

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ADMINISTRATION AND PHILOSOPHY OF RESEARCH

a * **The Essentials of Training.** Its purpose and meaning. Education and training officers are so much involved in the practical details of day-to-day training that it is often difficult for them to see the wood for the trees. *Coke and Gas*, v. 23, June 1961, p. 249-253.

b * **Electronic Data Processing and the Office Worker.** One expert's view of how personnel in the office are affected as computer use increases. ***Albert A. Blum.*** *Data Processing*, v. 3, June 1961, p. 11-14.

c * **The Place of Management in Modern Economy. Management—a Special Function.** Discusses for the most part the opinions of American experts. The source of the great part of the discussion was a symposium recently held by the American Society of Mechanical Engineers and particularly from papers prepared for delivery at the symposium by Peter F. Druckeron "Fifty Years of Management—a Look Backward and a Look Forward", and a joint paper by Mrs. L. M. Gilbreth and W. J. Jaffee on "Management's Past—a Guide to its Future." ***G. G. Archibald.*** *Canadian Mining Journal*, v. 82, June 1961, p. 79-83.

d * **Some Aspects of Engineering Education.** ***Willis Jackson.*** *Engineer*, v. 211, June 16, 1961, p. 980-981.

e **Long-Range Planning of Industrial Research.** For truly effective research planning, top management must: establish meaningful objectives as guides to research; see that both research people and operating management are attuned to the company's long-range technological needs and capacities; fit research into the company's over-all business strategy; make sure that project rankings and program balance reflect appropriate business judgments; and organize research and operations for maximum transfer of research technology to operations. ***James Brian Quinn.*** *Harvard Business Review*, v. 39, no. 4, July-Aug. 1961, p. 88-102.

f **IRSID, Cooperative Steel Research in France.** Concerns the Institut de Recherches de la Sidérurgie, better known as IRSID. ***J. Astier and L. Wahl.*** *Journal of Metals*, v. 13, June 1961, p. 411-416.

g **Reorganization of Science and Research in the U.S.S.R.** A new top-level government committee will coordinate interdisciplinary basic and applied research. ***Nicholas DeWitt.*** *Science*, v. 133, June 23, 1961, p. 1981-1991.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

h * **Aerodynamic Research Facilities at the Department of Aeronautical Engineering, Technion-Israel Institute of Technology.** Facilities are described. The aerodynamic facilities include the 60 x 90 cm closed return subsonic tunnel, and the 60 x 60 cm open-circuit low-speed tunnel. Two blow-down supersonic tunnels 10 x 10 cm and 30 x 30 cm fed by a high-pressure air supply of 1000 ft. at 200 atm. An induction transonic tunnel model 7 x 9 cm and a 7 meters long 7.5 x 7.5 cm shock tube are described. ***Josef Rom.*** *Research Council of Israel, Bulletin*, v. 9C, nos. 1-2, Feb. 1961, p. 107-118.

i **A Fixed-Base-Simulator Study of the Ability of a Pilot to Establish Close Orbits Around the Moon.** A study was made on a six-degree-of-freedom fixed-base-simulator of the ability of human pilots to modify ballistic trajectories of a space vehicle approaching the moon to establish a circular orbit about 50 miles above the lunar surface. ***M. J. Queijo and Donald R. Riley.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN*-D-917, June 1961, 53 pp. (TL570 Un3t Room 290)

j **Laminar Heat-Transfer and Pressure-Distribution Studies on a Series of Reentry Nose Shapes at a Mach Number of 19.4 in Helium.** An experimental investigation has been con-

k * Asterisks mark items that may be used in the Battelle Library only. None of the unbound materials listed are available for interlibrary loan.

ducted in the 2-inch helium tunnel at the Langley Research Center at a Mach number of 19.4 to determine the pressure distributions and heat-transfer characteristics of a family of re-entry nose shapes. The pressure and heat-transfer-rate distributions on the nose shapes are compared with theoretical predictions to ascertain the limitations and validity of the theories at hypersonic speeds. The experimental results were found to be adequately predicted by existing theories. Two of the nose shapes were tested with variable-length flow-separation spikes. The results obtained by previous investigators of spike-nose bodies were found to prevail at the higher Mach number of the present investigation. ***Richard D. Wagner, Jr., W. Clint Pine, and Arthur Henderson, Jr.*** *U. S. National Aeronautics and Space Administration Technical Note, NASA TN*-D-891, June 1961, 39 pp. (TL570 Un3t Room 290)

Theoretical Evaluation of the Pressures, Forces, and Moments at Hypersonic Speeds Acting on Arbitrary Bodies of Revolution Undergoing Separate and Combined Angle-of-Attack and Pitching Motions. Equations based on Newtonian impact theory have been derived and a computational procedure developed with the aid of several design-type charts which enable the determination of the aerodynamic forces and moments acting on arbitrary bodies of revolution undergoing either separate or combined angle-of-attack and pitching motions. Bodies with axially increasing and decreasing cross-sectional area distributions are considered; nose shapes may be sharp, blunt, or flat faced. The analysis considers variations in angle of attack from −90° to 90° and allows for both positive and negative pitching rates of arbitrary magnitude. The results are also directly applicable to bodies in either separate or combined sideslip and yawing maneuvers. ***Kenneth Margolis.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN*-D-652, June 1961, 32 pp. + graphs. (TL570 Un3t Room 290)

Artificial Aurora and Upper Atmospheric Shock Produced by Teak. Unclassified version of "Artificial Aurorae and Related Phenomena", in LAMS-2442, Contribution to Conference on Project Sane, July 6, 7, and 8, 1959, at Los Alamos, New Mexico. The northern branch of the artificial aurora and the features of the upper atmospheric shock produced by shot Teak exploded at 252,000 ft. above Johnston Island are described and analyzed. The correlation between the brightness-time history of the aurora and the decay of fission products is qualitatively good and a rather high conversion efficiency (~10%) for light emission is indicated. A pronounced slowing down of the upper shock was observed, which was caused by work against the geomagnetic field. The deep red appearance of this shock is believed to be due to excitation of the red auroral oxygen lines. The correlation between observed shock brightness and the light emission calculated on the basis of the computed shock temperature is discussed. The surprisingly high magnitude of the observed brightness of the front at plus 500 km is probably the result of interaction of the shock front with the compressed geomagnetic field. It is evident that various geo-astrophysical phenomena can be simulated and explored by the release of known amounts of nuclear energy in space. ***Herman Hoerlin.*** *U. S. Atomic Energy Commission, LAMS*-2536, June 9, 1961, 18 pp. (UF767 Un3.1La Contin.)

* **Preliminary Development of an Annular Jet Injector.** The paper describes research carried out at the Department of Aeronautical Engineering on an injector designed for operating the Department's transonic wind tunnel. Experiments were carried out in the low and high-subsonic ranges with a view to determining the influence of the injector components on its performance, using mixing tubes of variable length and two different diffusers. It was established that optimum mixing tube length ranges from $Lm/Dm = 2.5$ to 4 and that of a 4° diffuser permits improvement of performance. It was also found that the performance level of the injector in question is lower than those of similar systems described in references. This may be attributed to the negative influence of the transition piece between the rectangular and circular sections, separation of the secondary flow before the injection area and the geometry of the injection slot. Suggestions for improvement of performance are given. ***A. Kogan and M. Victor.*** *Research Council of Israel, Bulletin*, v. 9C, nos. 1-2, Feb. 1961, p. 79-106.

* **Prediction of Local Skin-Friction Coefficient by Transformation of the Compressible Boundary Layer With Heat Transfer.** This paper presents a transformation between compressible and incompressible two-dimensional and axisymmetric boundary-layer flows. The transformation may be used to predict local skin-friction coefficients for laminar and for turbulent flows, in zero as well as in favorable pressure gradient, and also for conditions with surface heat transfer through the use of the reference temperature. Application is limited, in the present version, to Prandtl number in the order of unity. The final form of the transformation involves a factor to be determined by comparison with experiment, and in the present case this is done for a particular range of data on air. Accordingly, quantitative application of the results will have greatest assurance for air over this same range, pending further data on other fields and ranges of flow conditions. Sample computations illustrate the application of the transformation to turbulent flow of air along an insulated flat plate with free stream Mach number of 3.7, and laminar boundary layer of air along a sphere with free stream Mach number of 2.855. These cases demonstrate good agreement between predicted and measured skin-friction coefficients as affected by aerodynamic heating. ***P. K. Chang and H. B. Nottage.*** *Franklin Institute, Journal*, v. 271, no. 6, June 1961, p. 445-457.

Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Triangular Wing and Canard With Twin Vertical Tails. The static aerodynamic characteristics of a canard airplane configuration having twin vertical stabilizing surfaces are presented. Selected portions of the data obtained in this investigation are compared with previously published results for the same model having a single vertical tail instead of twin vertical tails. ***Victor L. Peterson.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN*-D-1033, June 1961, 38 pp. (TL570 Un3t Room 290)

Theory of an Electromagnetic Mass Accelerator for Achieving Hypervelocities. For any electromagnetic accelerator which employs an electromagnetic force for driving the projectile and uses the projectile as the heat sink for the energy dissipated in it by ohmic heating, the maximum velocity attainable without melting is a function of the mass of the projectile. Therefore, for hypervelocities a large projectile mass is required and thus a power supply of very large capacity is necessary. It is shown that the only means for reducing the power requirement is maximizing the gradient of the mutual inductance. In the scheme of the sliding-coil accelerator investigated herein, the gradient of the mutual inductance is continuously maintained at a high value. It is also shown that for minimum length of the accelerator, the current must be kept constant despite the rise in induced voltage during acceleration. The use of a capacitor bank as an energy source with the condition that the current be kept constant is investigated. Experiments at low velocities are described. ***Karlheinz Thom and Joseph Norwood, Jr.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN*-D-886, June 1961, 36 pp. (TL570 Un3t Room 290)

* **Theoretical Pressure Distribution at Zero Lift at Supersonic Speeds for Slender Delta Wings Having Fuselages of Circular Cross Section.** A method is developed for calculating the pressure distribution at zero lift for a class of slender configurations consisting of a wing of delta type plan form combined with a body of revolution of the same over-all length. Slender-body and slender-wing theory are combined to take into account the interference between the wing and the fuselage. An expression is found for the pressure at a general point on the wing or fuselage, although some numerical integration is still needed. This expression is simplified to obtain algebraic formulae for the pressure at the wing-fuselage junction and along the top of the fuselage. A further simplification is possible when the fuselage radius is small compared with the local wing semi-span. A particular example is considered consisting of a "Newby" wing with a parabolic fuselage; pressure distributions and drag curves are calculated. ***R. C. Lock.*** *Aeronautical Quarterly*, v. 12, pt. 2, May 1961, p. 95-130.

* **Mass Transfer Cooling in a Boundary Layer.** Previous theoretical work on mass transfer cooling is reviewed and it is shown that this may be complemented by similar solutions that occur when the velocity outside a two-dimensional boundary layer varies as some power of the distance from the front stagnation point. The case of stagnation point flow with constant wall temperature is investigated in some detail, under the

assumption that the temperature differences are everywhere small compared with the absolute temperature. Calculations on an analogue computer, supplemented by an investigation of the asymptotic behavior, are used to determine the boundary layer development and heat transfer rates when the coolant is hydrogen, helium, steam or carbon dioxide. It is found that, on a mass flow basis, hydrogen reduces the heat transfer rate most and that steam is the next most effective of the substances investigated. ***D. G. Hurley.*** *Aeronautical Quarterly*, v. 12, pt. 2, May 1961, p. 165-188.

An Investigation of Separated Flows. II. Flow in the Cavity and Heat Transfer. The first portion of this paper describes studies of the internal structure of the separated flow in a notch at a free-stream Mach number of 3. Observations include: flow visualization, spark-schlieren pictures of the fluctuations of the free shear layer, and studies of the diffusion of heat from sources placed in the separated region. The second part describes measurements of local heat transfer to the wall. The external Mach number, the length-to-depth ratio of the cavity, the ratio of the oncoming boundary layer thickness to the notch depth (in the turbulent flow region), the thermal-to-momentum thickness ration of the boundary layer and, finally, the geometry of the internal boundary of the separated region are varied as systematically as possible. On the basis of these observations, a simple model of the flow in and the heat transfer across the separated region is formulated. ***A. F. Charwat, C. F. Dewey, Jr., J. N. Roos, and J. A. Hitz.*** *Journal of the Aero/Space Sciences*, v. 28, July 1961, p. 513-527.

The Newtonian Approximation in Magnetic Hypersonic Stagnation-Point Flow. The hypersonic flow of an electrically conducting fluid around the stagnation region of a sphere carrying a radial magnetic field is examined. By assuming a Newtonian pressure distribution and constant density, the differential equation of the inviscid flow is integrated and a simple closed-form solution is obtained. It is found that the ratio of the stand-off distances of the shock wave for the magnetic and nonmagnetic cases does not depend explicitly on the magnetic parameter S_* (ratio of the ponderomotive force to the free-stream inertia force) nor on the density ratio ϵ (the value at the free stream divided by the value behind the shock wave) but on the product $S_*\sqrt{\epsilon}$, at least for values of ϵ between 1/5 and 1/20. The velocity gradient on the body is also calculated and the ratio of the magnetic to the nonmagnetic case is shown to depend on the parameter $S_*\sqrt{\epsilon}$. The case of cylindrical shocks is also examined; the same general conclusions are drawn. ***Paul S. Lykoudis.*** *Journal of the Aero/Space Sciences*, v. 28, July 1961, p. 541-546.

A Summary of the Supersonic Pressure Drag of Bodies of Revolution. A number of approximate theories for supersonic and hypersonic flow over bodies of revolution at zero angle of attack are appraised by a critical comparison with characteristics and second-order results, with the use of hypersonic similarity as a basis for the comparison. Most of the approximate theories are inadequate except over very limited ranges of fineness ratio and Mach number. The combination of second-order supersonic theory and second-order shock-expansion theory provides consistently good results throughout the supersonic speed range. On the basis of exact (or nearly exact) supersonic solutions and a limited amount of test data and theory in the transonic region, summary design curves are developed that give the pressure drag of conical and ogive noses and conical and ogive boattails over the complete range of transonic, supersonic, and hypersonic Mach numbers. Other shapes can be analyzed in the same manner, provided that an equivalent amount of data is available. The analysis is made with the assumption of inviscid flow, so that the effects of boundary-layer growth, shock-boundary-layer interaction, and flow separation are not included. The present correlations provide a sound basis of inviscid-flow results from which these additional viscous effects can be evaluated. ***Deane N. Morris.*** *Journal of the Aero/Space Sciences*, v. 28, July 1961, p. 563-572.

Minimum Transfer Time for a Power-Limited Rocket. Found that flight must take place at maximum power and that the thrust-acceleration components are linear functions of time. The case of rectilinear transfer between positions of rest is treated in detail. ***George Leitmann.*** *ASME, Transactions, Series E, Journal of Applied Mechanics*, v. 28, no. 2, June 1961, p. 171-178.

a **On the Motion of Satellities With Critical Inclination.** Presents: libration of an earth satellite with critical inclination and motion of a particle with critical inclination in the gravitational field of a spheroid. *Smithsonian Contributions to Astrophysics*, v. 5, no. 5, 1961, 19 pp. (QB1 Sm69.1c Contin.)

b **Magnetorquer—a Satellite Orientation Device.** Satellite orientation torque is produced by the reaction of earth's magnetic field on current carrying coils in the satellite. Components of the system are a magnetometer to measure the field, a computer and a set of of coils. A torque command is assumed to be furnished from a guidance source. Adequate torque can be generated with reasonable weight and power at all altitudes up to 24 hr orbit. Torque cannot be produced about the instantaneous field axis, but since in general this axis varies with the position in orbit, any torque can be produced at some point in the orbit. The device may be used alone where this effect is permissible or it may be used to desaturate inertia wheels instead of using jets. The advantages of the system are simplicity, light weight, and zero propellant consumption. ***L. J. Kamm.*** *ARS Journal*, v. 31, June 1961, p. 813-815.

d **On the Aeroelastic Instability of Bluff Cylinders.** Static and dynamic wind-tunnel tests were made on cylinder models of square, rectangular, and D-section. ***G. V. Parkinson and N. P. H. Brooks.*** *ASME, Transactions, Series E, Journal of Applied Mechanics*, v. 28, no. 2, June 1961, p. 252-258.

e ## AGRICULTURE

f * **An Economist Takes a Second Look at Factors in Chemurgy's Future.** Recommends seven ideas designed to advance chemurgy. These proposals include a comprehensive inventory of chemurgic raw materials, development of a method and equipment for local processing of agricultural residues, conversion of existing surplus stocks to another form, technical-economic appraisal of existing chemurgic opportunities, an orderly and systematic review of new plant possibilities, appraisal of chemurgic research resources, and establishment of a chemurgic information center. ***Odin Wilhelmy, Jr.*** *Chemurgic Digest*, v. 20, Apr. 1961, p. 3-6.

g **The Biochemistry of Insects.** ***Darcy Gilmour.*** 343 pp. 1961. Academic Press, New York. (QL463 G42b)

h * **Using Waste Fruit Water of Starch Factories in Producing Protein Feeds.** The main conditions for the fermentation, such as pH nutrient dosage and the fermentation period, for a yield of about 9 g Torula dry substance from 1,000 ml fruit water were determined. A new technological procedure for the production of cheap, warm, liquid feed or also feed in dry form was suggested. (*In German.*) Ausnutzung des Abfall-Fruchtwassers von Stärkefabriken bei der fermentativen Gewinnung von Eiweissfutter. ***S. Zelenka and R. Čejková.*** *Stärke*, v. 13, June 1961, p. 240-247.

i * **High-Amylose Corn Starch Fractions.** To compare high-amylose corn starch and its fractions with ordinary or dent corn starch and its fractions, high amylose corn starches selected at six different levels of amylose content were separated into amylose and amylopectin. ***Edna M. Montgomery, K. R. Sexson, and F. R. Senti.*** *Stärke*, v. 13, June 1961, p. 215-222.

j ## BIOCHEMISTRY AND BIOPHYSICS

k **Net Formation of Polyribonucleotides With Base Compositions Analogous to Dexyribonucleic Acid.** Chromatographic isolation and spectrophotometric measurement of the individual bases show that the base composition of the RNA which is formed conforms to that of the DNA added. ***Audrey Stevens.*** *Journal of Biological Chemistry*, v. 236, no. 7, p. PC43-PC45.

Studies of the Transmission of Mouse Leukemia With Purified Nucleic Acid Preparations. Purified desoxyribose nucleic acid and ribose nucleic acid prepared from normal and leukemic tissues of a high incidence strain of mice (AKR) when injected into low incidence. ($C3H_f$ X AKR)F_1 hybrid mice have been shown to increase the incidence of leukemia. $C3H_f$/Bi mice have been shown to be resistant to leukemogenesis by these nucleic acid preparations. ***Esther F. Hays.*** *U. S. Atomic Energy Commission, UCLA-476,* June 6, 1961, 17 pp. (UF767 Un3.1uc Contin.)

Psychophysiological Aspects of Space Flight. ***Bernard E. Flaherty, editor.*** 393 pp. 1961. Columbia University Press, New York. (TL787 Sy68p)

Immunological Differences of Deoxyribonucleoproteins From White Blood Cells of Normal and Leukaemic Human Beings. The specificity of antibodies to normal and leukemic deoxyribonucleoproteins indicates the existence of a structural difference between the deoxyribonucleoproteins. This specificity, at the same time, argues for the nativity of these preparations; and it implies a genetic differentiation of the nuclear deoxyribonucleoproteins in the growth of white blood cells. ***Luigi Messineo.*** *Nature,* v. 190, June 17, 1961, p. 1122-1123.

* **On the Interaction Between Tumor Viruses and Cells: A Virogenetic Concept of Tumorigenesis.** A virus induces a hereditary transformation of a normal into a tumor cell, conditioned by the supplementary genetic information brought into the normal cell with the nucleic acid of the virus. Such a process cannot be considered a mutation, which is a change of the appropriate genome of the cell, but as a conversion of a normal into a tumor cell which involves incorporation of a genetic substance carrying additional genetic information. The reproduction of the cell with transformed heredity leads to the formation of a tumor, and as an entity the virus will take no part in this process, though it may still exist in the mature form in some tumors. Certain alterations of antigenic structure occur in tumor cells, and they cease then to submit to the growth regulation systems of the organism. The data presented show that some tumors induced by chemical or physical factors are conditioned by latent viruses; therefore the above concept may have a general significance. ***L. A. Zilber.*** *U. S. National Cancer Institute, Journal,* v. 26, no. 6, June 1961, p. 1311-1319.

CERAMICS AND CONCRETE

* **The Service of Magnesite Brick in Furnaces Used in Smelting Manganese Alloys.** The use of compact magnesite bricks increases the strength of the lining of furnaces for the smelting of metallic Mn and Mn slag. The strength of Mn brick lining with between 11 and 13% porosity is of 1080 hours. Using large size bricks increases the strength of the furnace bottom. (*In Russian.*) O sluzhbe magnezitovogo kirpicha v pechakh dlia vyplavki margantsevykh splavov. ***V. S. Zel'din and I. A. Drekalovich.*** *Ogneupory,* v. 26, no. 6, 1961, p. 269-272.

Proportioning and Production of Structural Concretes With Light-Weight Aggregates. Characteristics of processed lightweight aggregates suitable for use in structural concretes; their effects on workability, water content, and methods of proportioning. ***James M. Antill.*** *Current Engineering Practice,* v. 3, no. 9, Mar. 1961, p. 1-10.

Correlation Between Physical Properties and Thermochemical Reactions in a Mullite-Cordierite Composition. A theoretical composition of 9.2% MgO, 47.4% Al_2O_3, and 43.4% SiO_2 was subjected to a variety of thermal treatments. The purpose of the investigation was the determination of the relationship between the fired properties of the mullite cordierite body and the thermal treatments received. ***M. P. Davis, Jr. and W. C. Hackler.*** *American Ceramic Society Bulletin,* v. 40, June 1961, p. 362-365.

The Sintering Characteristics of BeO. Effect of calcining temperature and water vapor; effect of $AlO_{1.5}$, $CrO_{1.5}$, MgO, and NiO additives. All additives studied promoted sintering without the presence of a liquid phase. ***E. A. Aitken.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 302-310.

Some Effects of Thermal Shock on Flow and Fracture in Crystals of Magnesium Oxide. Mono- and bi-crystals of MgO were thermally shocked by contact with an arc plasma. This plasma transferred energies of up to several joules cm^{-2} during about 20 μsec. The resulting dislocation movements and crack propagation are described and discussed. ***F. J. P. Clarke, R. A. J. Sambell, and G. D. Miles.*** *British Ceramic Society, Transactions,* v. 60, May 1961, p. 299-329.

Furnace Periscope and Flow Visualization. The furnace periscope and its use to inspect and photograph the interior of ceramic kilns are described. Various methods of flow visualization were applied, and the results proved that certain theories of gas flow in kilns are correct. Nonluminous invisible flames were visualized by using the flame coloring agents which are so well known in the flame tests of qualitative analysis. Trimethyl borate has so far proved the most suitable agent. Hot gases were also visualized by introducing a small neat-acetylene torch which burns with a very smoky flame. An investigation of an earthenware fault in a biscuit kiln is described in which the flow of gases at the entrance end of the kiln was shown to cause the fault. A tunnel-kiln firing heavy clay products was investigated and the flow patterns filmed and studied. ***P. L. Scorey, W. H. Holmes, and E. Rowden.*** *British Ceramic Society, Transactions,* v. 60, May 1961, p. 343-362.

CHEMICAL ENGINEERING

* **Sonic Emulsification.** Piezoelectric generators; magnetostriction generators; size frequency analysis. ***Donald M. Skauen and Harold M. Beal.*** *Society of Cosmetic Chemists, Journal,* v. 12, no. 5, June 1961, p. 293-301.

Cooling Down Desalting Costs. Like the Carrier process, the Umano process separates fresh water from sea water by freezing out crystals of pure ice through direct refrigeration. It removes the heat of fusion for ice formation with a secondary refrigerant, boiling butane or isobutane. The Carrier process uses water vapor itself. *Chemical Week,* v. 88, no. 25, June 24, 1961, p. 93 + 2 pages.

* **Study on Zinc Oxide-Chromium Oxide Catalyst. I. Electrical Conductivity of Zinc Oxide in Oxygen and Hydrogen. II. Variation of Catalytic Activity for Methanol Decomposition With Addition of Chromium Oxide and Structural Dependence of Activity. III. Promoting Effect of Chromium Oxide on Catalytic Activities for Methanol Synthesis and Decomposition. IV. Dependency of Catalytic Activity on Catalyst Structure.** (*In Japanese.*) I-II. ***Hiroshi Uchida and Yoshisada Ogino.*** III-IV. ***Yoshisada Ogino, Masaaki Oba, and Hiroshi Uchida.*** *Government Chemical Industrial Research Institute, Tokyo, Reports,* v. 56, Apr. 1961, p. 119-149.

* **Graphs Cut Exchanger Design Time.** If the maximum allowable pressure drop on the shell and tube sides and the heat duty in Btu/hr is known, the minimum exchanger required can be determined. ***J. Starczewski.*** *Petroleum Refiner,* v. 40, June 1961, p. 165-172.

* **Now Revise Those Hydrocracking Costs.** Recent commercial-scale operations feeding heavy catalytic cycle oil and heavy straight run gas oil demonstrate the flexibility of the Isocracking process. Tells how latest design studies show substantial reductions in investments and operating costs for this process. ***J. A. Robbers, N. J. Paterson, and W. T. Lane.*** *Petroleum Refiner,* v. 40, June 1961, p. 147-154.

The P.V.T.-Behavior of Diatomic Substances in Their Gaseous and Liquid States. The critical compressibility factor has been used as a criterion for the correlation of the P.V.T.-behavior in the gaseous and liquid states for the diatomic gases, N, O, CO, NO, Cl, HCl. ***Robert Byrne and George Thodos.*** *A.I.Ch.E. Journal,* v. 7, no. 2, June 1961, p. 185-189.

Mass Transfer Between Isobutanol and Water in Concurrent Flow Through a Packed Column. These are the first rate measurements for concurrent flow in a packed bed. Because the flow rates are not limited by flooding, much higher rates of transfer are attainable than in countercurrent flow.

James A. Leacock and Stuart W. Churchill. *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 196-199.

Deposition of Aerosol Particles in Fibrous Filters. For the aerosol employed, the results showed a minimum collection efficiency at a velocity of 2 to 5 ft/sec., dependent on fiber size. At the lower velocities, where diffusion is controlling, collection efficiency increased with decreased velocity; at higher velocities, where inertia is controlling, efficiency increased with increased velocity. ***D. G. Thomas and C. E. Lapple.*** *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 203-210.

The Effect of Vibration on Natural Convective Mass Transfer. Small horizontal cylinders subliming to room air were vibrated in a vertical direction at 20 to 118 cycles/sec. Increases of up to 660% in the coefficient of mass transfer were thus obtained. ***Robert Lemlich and Martin R. Levy.*** *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 240-242.

* **Effects of the Porosity of the Carrier on the Activity of the Melting Catalyst of Hydration in the Liquid Phase.** Studies the dependence of the activity of a catalyst for the liquid-phase hydration of heavy tar and petroleum residues on the active Fe contained, and on the porosity of the carrier. A determining influence on the activity of the catalyst is exerted by the average radius of the pores and by the specific surface of the carrier, which respectively must not be lower than 15 to 19 Å and 40 m^2/g. (*In Russian.*) Vliianie poristosti nositelia na aktivnost' plavaiushchego katalizatora gidrirovaniia v zhidkoĭ faze. ***N. M. Zaidman and M. F. Gladovskaia.*** *Khimiia i Tekhnologiia, Topliv i Masel*, v. 6, no. 6, June 1961, p. 27-29.

A Horizontal Vacuum Distillation Column. Above is described with partial vaporization and condensation effects to give a low-pressure drop for 10-15 transfer units when a methylcyclohexane-toluene mixture is distilled at 200 mm. Hg pressure. ***S. R. M. Ellis and J. R. Suárez.*** *Industrial Chemist*, v. 37, June 1961, p. 281-284.

* **Liquid Ion Exchange—Promising Union of Solvent Extraction and Ion Exchange.** Now well established in commercial concentration of U- and V-bearing solutions, liquid ion exchange is zeroing in on other applications. Main targets include extraction of acids and recovery of catalysts from process streams. *Chemical Processing*, v. 24, June 1961, p. 23-25.

* **Industrial Cryogenics.** Explores some facets of the low-temperature field with seven articles, including use of high-purity chlorinated hydrocarbons, prospects for liquid H, and the role of aluminum alloys and nickel steels. *Chemical Processing*, v. 24, June 1961, p. 27-50.

Filament-Wound Pressure Vessels. A discussion of the materials and technique for winding pressure vessels is presented in a qualitative manner. A brief design criterion is given. ***Richard Gorcey.*** *Machine Design*, v. 33, June 22, 1961, p. 178 + 3 pages.

Let Glycols Help Inhibit Hydrate Formation. II. Ethylene vs. Diethylene Glycol. Includes pointers on how to prevent or correct common operating troubles. ***J. L. Arnold and R. Pearce.*** *Oil and Gas Journal*, v. 59, no. 27, July 3, 1961, p. 125 + 3 pages.

* **Transportation of Solids in Conduits—Industrial Application Possibilities.** Objective is to outline the studies done by the Sogreah-LaSalle Hydraulic Laboratory group and installations built in this field by the firm Neyrpic. The investment necessary for a hydraulic transport system is nearly always much less, if the classical means do not already exist (roads, railways). ***E. Condolios, P. Couratin, and E. Pariset.*** *Engineering Journal*, v. 44, June 1961, p. 62-67.

* **Studies in Optimization. IV. The Optimum Conditions for a Single Reaction.** Shows how an explicit solution to the problem of finding the minimum holding time and best temperature profile may be obtained for a tubular or batch reactor. The form which this takes allows a complete parametric study for given kinetics and full results are presented for a first-order reversible reaction. For the sequence of stirred tank reactors both the minimum holding time and optimum temperature of each stage can be found by a simple graphical construction. ***R. Aris.*** *Chemical Engineering Science*, v. 13, no. 4, June 1961, p. 197-206.

CHEMISTRY—ANALYTICAL (ORGANIC AND INORGANIC)

* **Detection of Selenium in Organic Spot Test Analysis.** This test is based on the oxidative decomposition with hot concentrated perchloric acid to yield selenic acid, which reacts with hydrazine to give red elemental Se. Microchemical limits of identification are reached within the technique of spot test analysis. ***Fritz Feigl.*** *Analytica Chimica Acta*, v. 24, no. 6, June 1961, p. 501-504.

* **Synthesis of Some Unsaturated Ketones Containing a Thiophene Nucleus.** A fair yield of unsaturated ketones of the thiophene series was obtained by the croton condensation method from 2 thiophene-aldehyde, 2-acetothiene, 2-thienylacroleine, and corresponding aromatic aldehydes and ketones. Some properties are described. (*In Russian.*) Sintez nekotorykh nenasyshchennykh ketonov soderzhashchikh iadro tiofena. ***V. F. Lavrushin, S. V. Tsukerman, and V. M. Nikitchenko.*** *Ukrainskiĭ Khimicheskiĭ Zhurnal*, v. 27, no. 3, 1961, p. 379-384.

* **Extraction of Phenol Titanium Complexes.** The tinted compounds Ti^{4+}, Fe^{3+}, V^{5+}, V^{4+}, Mo^{6+}, U^{6+}, Ce^{4+} with pyrocatechin, pyrogallol, and gallic acid are extracted by some organic solvents, the best of which is n-butanol. The degree of extraction of phenol Ti compounds depends on the pH of the solution, and on the concentration of phenol in the aqueous phase. (*In Russian.*) Ekstraktsiia fenol'nykh kompleksov titana. ***S. Ia Shnaĭderman and I. E. Kalinichenko.*** *Ukrainskiĭ Khimicheskiĭ Zhurnal*, v. 27, no. 3, 1961, p. 402-407.

* **The Separation of Zinc, Manganese and Cobalt From Iron by Reversed-Phase Chromatography.** The conditions of separation of bi-valent cations of Mn, Zn, and Co from the trivalent cation of Fe by the reversed-phase partition chromatography were investigated, using the radioisotopes of ^{59}Fe, ^{54}Mn, ^{60}Co and ^{65}Zn. ***Jan Mikulski and Ignacy Stroński.*** *Nukleonika*, v. 6, no. 4, 1961, p. 295-298.

Advances in X-Ray Analysis. Vol. I contains the proceedings of the Six Annual Conference on Applications of X-ray Analysis, Aug. 7-9, 1957. Vol. II reports the Seventh Annual Conference Proceedings, Aug. 13-15, 1958. Vol. III reports the Eighth Annual Conference Proceedings, Aug. 12-14, 1959. ***William M. Mueller, editor.*** v. I. 494 pp.; v. II. 359 pp.; v. III. 376 pp. 1960. Plenum Press, New York. (QC481 Ad95 Vis.)

* **Radiochemical Separation of Cobalt.** Method based on the extraordinary stability of cobalt diethyldithiocarbamate. Interferences are few; only very small amounts of Zn and Fe accompany Co, which is important in neutron-activation analysis. ***P. C. van Erkelens.*** *Analytica Chimica Acta*, v. 24, no. 6, June 1961, p. 526-528.

Identification of Hydrocarbon Types in "Ultrasene". The C_{11}-C_{14} components of a sample of "Ultrasene" were identified as normal- and isoparaffins; mono-, bi-, and tri-cycloparaffins; alkylbenzenes; indans; indenes; naphthalenes; and acenaphthenes. The aromatic content of this sample was 3.0 vol%. ***Richard N. Wilhite.*** *U. S. Atomic Energy Commission, DP-571*, Apr. 1961, 12 pp. (UF767 Un3.1dp Contin.)

* **Spectrophotometric Studies on Organometallic Complexes Used in Analytical Chemistry. VII. Spectrophotometric Determination of Uranium With Flavonol.** ***Takuji Kanno.*** *Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy*, v. 13, no. 2, Apr. 1961, p. 91-95.

* **Nucleation in Analytical Chemistry. II. Nucleation and Precipitation of Silver Chloride From Homogeneous Solution. III. The Precipitation Nucleus of Silver Chloride.** ***David H. Klein, Louis Gordon, and Thomas H. Walnut.*** *Talanta*, v. 3, no. 2, Dec. 1959, p. 177-190.

* **A Gamma Absorptiometer for Laboratory Analysis of the Heavy Elements.** Construction of a simple gamma absorptiometer employing a small ^{241}Am source, for the determination of U or Pu in relatively pure solutions, is described. The instrument yields a recorded voltage directly proportional to absorbance. ***W. L. Maddox and M. T. Kelley.*** *Talanta*, v. 3, no. 2, Dec. 1959, p. 172-176 + 1 plate.

* **Evaluation of Crude Benzol by Gas Chromatography.** Medicinal oil on granulated nonpolished porcelain was used as the separation liquid. Nitrogen was the carrying gas. The constituents of the specimens appearing at the separation column were determined with a microflame detector. Methylcyclohexane was used as an internal standard for the determination of benzol and toluol. Xylol concentration was determined by comparison of the peak surface of toluol with that of the xylol fraction. (*In German.*) Die Bewertung von Rohbenzol mittels Gaschromatographie. ***J. Romováček and Z. Novotny.*** *Brennstoff-Chemie,* v. 42, no. 5, May 1961, p. 161-165.

* **Titration of Sulfonyl, Sulfinyl and Sulfenyl Chlorides by Sodium Sulfide.** Describes a method for the polar-voltmetric titration of aliphatic, aromatic, and heterocyclic sulfonyl chlorides by means of an aqueous solution of sodium sulfide. Even solutions with 0.001 M of sulfonyl chloride can be titrated. Trichloromethyl-sulfenyl chloride was titrated also under the same conditions. (*In French.*) Titrage des chlorures de sulfonyle, sulfinyle et sulfényle par le sulfure de sodium. ***W. Walisch, D. F. Hertel, and M. R. F. Ashworth.*** *Chimie Analytique,* v. 43, May 1961, p. 234-237.

* **Remarks Concerning the Quantitative Determination of Sulfur in Steels.** Complete combustion of the sample analyzed was obtained, owing to some details of the apparatus used for this determination. The flow of the dehydrated O current through a refractory porous container containing the sample, and raised to a temperature as high as 2,200 C, caused the oxidation of S and C. Acidimetric methods of redox were used for the quantitative determination of the sulfur oxides carried away by the gas current. (*In French.*) Remarques sur le dosage du soufre dans les aciers. ***R. Boulin and E. Jaudon.*** *Chimie Analytique,* v. 43, May 1961, p. 221-224.

* **Identification and Separation of Aliphatic Amines in the Form of N,N-Dialkyl 3,5-Dinitrobenzamides.** The derivatives were produced in their pure state and their identification constants were determined. The 3,5-dinitrobenzamides of the secondary aliphatic amines were separated and identified by paper chromatography. (*In Russian.*) Identifikatsiia i razdelenie vtorichnykh alifaticheskikh aminov v forme N,N-dialkil-3,5-dinitrobenzamidov. ***B. Volakova.*** *Collection of Czechoslovak Chemical Communications,* v. 26, no. 5, May 1961, p. 1332-1336 + 2 plates.

* **Colorimetric Determination of Low Molybdenum Amounts According to a Modified Rhodanide Method.** The anionic colored Mo compounds produced from rhodanide-containing Mo solutions after reduction with $SnCl_2$ can be extracted with chloroform after addition of substituted phosphonium salts and can be used for the colorimetric determination of low Mo amounts (0.5 - 10μg). Procedure, reproducibility and disturbances are indicated. (*In German.*) Die colorimetrische Bestimmung kleiner Molybdänmengen nach einem modifizierten Rhodanidverfahren. ***Rolf Neeb.*** *Zeitschrift für Analytische Chemie,* v. 182, no. 1, 1961, p. 10-13.

* **The Determination of Tin in Pure Iron, Mild Steel and Certain Low-Alloy Steels by Cathode-Ray Polarography.** A method is described in which a linear-sweep cathode-ray polarograph is used for determining Sn in pure Fe and mild steel. Tin is separated by co-precipitation with manganese dioxide and is determined in a base electrolyte containing peptone and ascorbic acid in 5 M hydrochloric acid. Molybdenum interferes, but, provided that the Mo content of the sample does not exceed 0.5%, a correction can be made, so that the method may also be used for the analysis of low-alloy steels. The method is suitable for Sn contents down to 0.001%, and a standard deviation of 0.001% is claimed at the 0.02% level. ***P. H. Scholes.*** *Analyst,* v. 86, June 1961, p. 392-399.

* **Separation and Colorimetric Determination of Trace Quantities of Magnesium in High-Purity Beryllium Oxide.** Be is separated from the magnesium by forming the beryllium perfluorobutyrate salt and then extracting it with several portions of diethyl ether. Method applied to the determination of quantities of magnesium as low as 10μg. ***R. F. Apple and J. C. White.*** *Talanta,* v. 8, no. 6, June 1961, p. 419-425.

* **Titrimetric Determination of Vanadium^{III} With Sodium Metavanadate Using Redox Indicators.** Conditions developed for the accurate titrimetric determination of vanadium^{III} with sodium metavanadate, using diphenylbenzidine, barium diphenylamine sulphonate or *N*-phenylanthranilic acid as an internal indicator. ***B. V. S. R. Murty and G. Gopala Rao.*** *Talanta,* v. 8, no. 6, June 1961, p. 426-430.

* **The Determination of Nitrite in Water.** ***H. A. C. Montgomery and Joan F. Dymock.*** *Analyst,* v. 86, June 1961, p. 414-416.

* **Preparation of Oxy-3-Triazoles-1.2.4.** In the presence of sodium methylate, the aryl-4-semicarbazides condense with ethyl formiate and lead directly to oxy-3-aryl-4-triazoles-1,2,4. With the esters of higher fatty acids, the reaction yields acyl-1-aryl-4-semicarbazides which can be cyclized into oxytriazoles by heating with aqueous soda. Ethyl carbonate condenses easily with aryl-4-semicarbazides. Thus aryl-4-urazoles are obtained directly. (*In French.*) Sur la préparation des oxy-3 triazoles-1.2.4. ***Marcel Pesson and Simone Dupin.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 24, June 12, 1961, p. 3830-3832.

CHEMISTRY—INORGANIC AND GENERAL

* **New Inorganic Azo-Compounds: the Azo-Diphosphonic Acid Derivatives.** The alkaline saponification of hydrazine-diphosphonic acid-tetraphenyl ester(I) leads through the dipotassium salt of hydrazine-diphosphonic acid-diphenyl ester(II), which salt can be isolated and serves as a transition stage, to tetrapotassium-hydrazine-diphosphonate(III). From the hydrazines I, II, and III it is possible with suitable oxidizers to produce the red to purple, thermally unexpected stable azo compounds $X_2O_3P\text{-}N{=}N\text{-}PO_3X_2$(IV:X=$C_6H_5$; V:X=K, C_6H_5; and VI:X=K) as new inorganic "diazenes". (*In German.*) Neue anorganische Azo-Verbindungen: Derivate der Azo-diphosphonsäure. ***Hans Bock and Günter Rudolph.*** *Chemische Berichte,* v. 94, no. 6, 1961, p. 1457-1464.

An Introduction to Transition-Metal Chemistry Ligand-Field Theory. This book deals with the areas in transition-metal chemistry which have been most strongly influenced by electronic theory in the years since the war. The earlier chapters deal with ionic solids and the field of classical coordination chemistry. The second part of the book is concerned with carbonyls, dicyclopentadienyls and a variety of topics of contemporary interest. ***Leslie E. Orgel.*** 180 pp. 1960. John Wiley & Sons, New York. (QD171 Or4i)

The Reaction of Diboron Tetrachloride With Some Simple π-Bonded Molecules. The possibility of forming 1:1 adducts of diboron tetrachloride with nitrogen, oxygen, carbon monoxide and nitric oxide has been examined. Nitrogen and pure carbon monoxide do not react; oxygen forms boric oxide and boron trichloride, but intermediate formation of a 1:1 adduct is postulated. Nitric oxide forms a 1:1 adduct which decomposes at -40° to give a white solid $B_2(NO)_2BCl_3$, from which boron trichloride can be slowly released by pumping, violently released by heating, and removed by trimethylamine. The solid $B_2(NO)_3$ is thermally stable and resists hydrolysis; an oxide-like structure in which boron trichloride is occluded is suggested. ***A. K. Holliday and A. G. Massey.*** *Journal of Inorganic and Nuclear Chemistry,* v. 18, Mar. 1961, p. 108-112.

Reactions of Hydrogen Fluoride With Metals and Metalloids. Closed-system reactions of liquid hydrogen fluoride with a number of metals, metalloids, and refractory materials have been investigated. The reaction with metals proved to be a good route to pure fluorides. The closed-system furnished two unique features: the H generated in the fluorination maintained a strong reducing atmosphere that permitted isolation of otherwise difficultly obtainable fluorides of lower oxidation state, e.g., TiF_3 and NbF_2, and the H is also believed to have contributed significantly to the reactivity of many of the transition metals by forming a metal hydride intermediate. ***E. L. Muetterties and J. E. Castle.*** *Journal of Inorganic and Nuclear Chemistry,* v. 18, Mar. 1961, p. 148-153.

Polymerization in Cobaltic Periodate Solutions. Acidified solutions of $Na_5H_2Co(IO_6)_2.10H_2O$ show the presence of two types of periodate ions as evidence by the fact that a portion, but not all, of the periodate may be removed by pre-

cipitation or reduction without changing the absorption spectra. Polymerization of the Co species to form soluble polynuclear complex having a cobalt(III) to periodate ratio of 4:3 occurs at a measurable rate which increases with increasing hydrogen ion concentration. From a 2 *M* perchloric acid solution, a dark green crystalline solid is obtained which has three strongly ionized hydrogen ions and three I_2 atoms per four Co atoms. The crystals are soluble in water and have an elemental analysis and equivalent weight leading to a postulated formula $H_3[Co_4I_3O_{30}H_{24}]$ for their composition. ***C. J. Nyman and R. A. Plane.*** *American Chemical Society, Journal,* v. 83, June 20, 1961, p. 2617-2620.

* **Effects of Alkali Metals on Gallium.** Sodium and K combine with Ga to form two definite compounds in each system. These compounds melt at high temperature. Two of these compounds are formed by peritectic reaction in a vacuum and their formula was established owing to centrifuging in a vacuum so that they could be isolated in the pure state by separation of the liquid Ga in excess. (*In French.*) L'action des métaux alcalins sur le gallium. ***Émile Rinck and Pierre Feschotte.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 23, June 5, 1961, p. 3592-3594.

* **A Contribution to the Study of Lithium Borates and Sodium Borates.** Some new borates were revealed by examining the binary oxide system of boric lithium anhydride. The study was continued using hydrated borates (sodium borates, monoborate and pentaborate). (*In French.*) Contribution a l'étude des borates de lithium et de sodium. ***Roger Bouaziz.*** *Annales de Chimie,* v. 6, Mar.-Apr. 1961, p. 345-393 + 4 plates.

Reactor-Irradiated Phosphoryl Chloride. Samples of $POCl_3$ were reactor irradiated for varying periods of time in a thermal neutron flux of approximately 6×10^{11} n cm^{-2} sec^{-1}. The irradiated samples were examined by carrier distillation techniques which showed the presence of $^{32}PCl_3$, $^{32}POCl_3$, and a labeled high-boiling component. A changing distribution of ^{32}P in the products was observed. The percentage of total ^{32}P found in combination as $^{32}PCl_3$ decreased from about 60% to less than 10% with increasing irradiation time while that found as $^{32}POCl_3$ increased from about 30% to greater than 80%. Phosphorus exchange in the system PCl_3-$^{32}POCl_3$ was investigated and appeared to be negligible for the distillation conditions used in this study. ***T. J. Clark and H. C. Moser.*** *Journal of Inorganic and Nuclear Chemistry,* v. 17, nos. 3-4, June 1961, p. 210-214.

CHEMISTRY—ORGANIC

* **The Influence of Non Planarity in Styrene and Stilbene Derivatives. III. Syntheses and Ultra-Violet Spectra of 4-4′-Substituted Cis- and Trans-Stilbenes.** A series of stilbenes were synthesized and their ultraviolet absorption spectra recorded. The differences between the spectra of the trans-compounds and the sterically hindered *cis*-isomers as well as the influence of the substituents on the spectra are discussed by means of a semiquantitative treatment. ***C. Riezebos and E. Havinga.*** *Recueil des Travaux Chimiques des Pays-Bas,* v. 80, May 1961, p. 446-467.

* **Spectroscopic Investigations of Organometallic Compounds. V. Infrared Spectra of Organotellurium Compounds.** The I. R. spectra of 15 organotellurium compounds and of some other organochalcogene compounds in the region of 4000-250/cm are given. Te-C valence frequencies in alkyl or phenyl derivatives are determined at 477-529/cm and 455-487/cm. A comparison of the bonding forces is carried out for dimethyl-chalcogenes. (*In German.*) Spektroskopische Untersuchungen an organometallischen Verbindungen. V. Infrarot-Spektren von Organotellurverbindungen. ***Heinz P. Fritz and Heimo Keller.*** *Chemische Berichte,* v. 94, no. 6, 1961, p. 1524-1533.

* **A Contribution to the Knowledge of Functional Si,O,N-Heterocycles.** During the reaction of symmetrical *bis*-brommethyl-tetramethyl-disiloxane with amines having several functions which possess amino or hydroxyl in β-position, in the case of primary amines, N-substituted-2,6-disila-morpholines are formed during the separation of bromine hydrogen; with secondary β-hydroxyethyl-amines, N-substituted-2-sila-morpholines are formed during the separation of bromine hydrogen and water. (*In German.*) Zur Kenntnis von funktionellen Si,O,N-Heterocyclen. ***Walter Simmler.*** *Chemische Berichte,* v. 94, no. 6, 1961, p. 1585-1591.

* **A Contribution to the Chemistry of the "Energetic Phosphates". XI. Preparation of Imidazolides of Phosphoric Acid.** Imidazolides of phosphoric acid-monoesters(III, R=H) and orthophosphoric acid (III, R and R′=H) were obtained by reaction of N,N′-carbonyl-diimidazole(II) with the corresponding phosphoric acids. Imidazolide of the adenosine-5-phosphoric acid(VI) was explained in the same way. Imidazolyl-(1)-phosphonates were obtained directly from the corresponding acid chlorides and imidazole. (*In German.*) Zur Chemie der "energiereichen Phosphate". XI. Darstellung von Imidazoliden der Phosphorsäure. ***Friedrich Cramer, Heinz Schaller, and Heinz A. Staab.*** *Chemische Berichte,* v. 94, no. 6, 1961, p. 1612-1621.

* **Concerning 1,4-Oxazines. I. Production of Condensed 1,4-Oxazinones-(2) by Reaction of *o*-Aminophenols With α-Ketoesters.** With α-ketone carboxylic acid esters, *o*-aminophenols, aminonaphthols and other aromatic hydroxy-amino compounds react and produce condensed 1,4-oxazinones-(2). Because of their remarkable crystallization properties, these compounds are suitable for the characterization of aromatic hydroxy-amino compounds and of α-ketoesters. (*In German.*) Über 1.4-Oxazine. I. Darstellung kondensierter 1.4-Oxazinone-(2) durch Umsetzung von *o*-Aminophenolen mit α-Ketoestern. ***Ernst Biekert, Dieter Hoffmann, and Friedrich J. Meyer.*** *Chemische Berichte,* v. 94, no. 6, 1961, p. 1664-1675.

* **Thiophenes & Thiapyrans. XXVI. Synthesis of Condensed Thiophenes From Diaryls.** Thionation of 3-phenylthionaphthene, 3,3′-dithionaphthenyl, 2,3′-dithionaphthenyl and 2-phenylthionaphtheno-(2,3-b)-thiophene has been studied in the absence or in the presence of anhydrous aluminum chloride. The structures of the thionation products have been proved by Raney nickel desulfurization. ***T. Srinivasa Murthy, L. J. Pandya, and B. D. Tilak.*** *Journal of Scientific & Industrial Research,* v. 20B, Apr. 1961, p. 169-176.

* **Merocyanines Derived From 5-Phenylamino-2-Methyl-1,3,4-Thiadiazole.** From 5-phenylamino-1,3,4-thiadiazole as the fixed basic nucleus, and oxazolone, isooxazolone, N-phenyl rhodanine, diphenyl thiobarbituric acid and *o*-tolyl thiohydantoin as the variable acidic component. The deviations in their absorption maxima have been calculated, and with the help of the deviation data, the relative acidities of the various acidic nuclei used have been determined. The relationship between relative acidity and deviation has been clearly brought out by considering the energy-level diagrams. ***P. B. Tripathy and M. K. Rout.*** *Journal of Scientific & Industrial Research,* v. 20B, Apr. 1961, p. 177-181.

* **Alcoholic Solvents for Rauwolfia-Alkaloids.** The alkaloids in one part of rauwolfia roots were fully dissolved by six parts methanol, ethanol or isopropanol by heating in a water bath. Of the three alcohols the most suitable is isopropanol, since it dissolves also the smallest ballast materials. Rauwolfia roots or extracts cannot be titrated. The amount of roots used was three to four grams. (*In German.*) Alkoholische Lösungsmittel für Rauwolfia-Alkaloide. ***Werner Huhn.*** *Chemiker-Zeitung/Chemische Apparatur,* v. 85, no. 11, June 5, 1961, p. 384-385.

Organogermanium Compounds. A survey of the literature from Jan. 1950 to July 1960. ***F. Rijkens.*** 97 pp. Nov. 1960. Drukkerij en Uitgeverij Schotanus & Jens, Utrecht, Holland. (QD412.G5 R44o)

Studies on the Syntheses of Chlorophthalic Acids and Chloroquinizarins. 4-Chlorophthalic acid is a valuable intermediate for the preparation of noncrystallizing Cu-phthalocyanine and anthraquinone dyes, and a few methods for the preparation of this acid have already been reported. The acid, however, has not been manufactured in our country because of the difficulty of performing the chlorination of phthalic acid. Therefore, the optimum conditions for the preparation of 4-chlorophthalic acid by the chlorination of phthalic acid have been studied. (*In Japanese.*) ***Yoshié Bansho, Shigeru Suzuki,***

and Iho Saito. *Government Chemical Industrial Research Institute, Tokyo, Reports,* v. 56, Apr. 1961, p. 158-164.

* **Some Ketomanoyl Oxides.** 1-Keto and 3-ketodihydromanoyl oxides have been prepared, and their rotatory dispersion curves compared with that of 2-ketodihydromanoyl oxide. ***R. Hodges.*** *Tetrahedron,* v. 12, no. 4, May 1961, p. 215-218.

* **New Less Toxic Insecticides on the Basis of Phosphoric Acid Esters.** Numerous attempts of modifying the molecular structure of methyl-parathion in such a way that less toxic agents are formed which, on the other hand, are active insecticides, led to 4-methylmercapto-3-methylphenyl-O,O-dimethylphosphorothioate. The detoxicating principle (introduction of a methyl group in ortho position to the methylmercapto or nitro group) is applied to corresponding *N*-methylcaramates. (*In German.*) Zur Kenntnis neuer, wenig toxischer Insektizide auf der Basis von Phosphorsäureestern. ***G. Schrader.*** *Angewandte Chemie,* v. 73, no. 10, May 21, 1961, p. 331-334.

The Chemical Interaction of Accelerated Carbon-14 Ions With Benzene. Solid benzene at -160° was irradiated with singly charged ^{14}C ions in an isotope separator. Irradiation was performed at three different ion energies: 5000 ev, 90 ev, and 45 ev. The yields of three products of the irradiation—^{14}C-labeled benzene, toluene, and cycloheptatriene—were found to decrease with decreasing ion energy. In addition to benzene, toluene, and cycloheptatriene, the following ^{14}C-labeled compounds were identified as products of the irradiations: allene, propyne, 1,2-butadiene, 1,3-butadiene, 1 and (or) isobutene and 1-butyne. Trace amounts of n-butane, and indirect evidence for propane, were observed. ***Robert Terrence Mullen.*** *U. S. Atomic Energy Commission, UCRL-*9603, Mar. 14, 1961, 263 pp. (UF767 U3u Contin.)

Infrared Spectra of Hydroxy-Aromatic Organic Compounds. In characterizing tars obtained by the low-temperature carbonization of North Dakota lignite, infrared spectra have been an invaluable aid in both qualitative and quantitative examination. Quite early in the tar-research program of the Federal Bureau of Mines it became evident that the small number of published spectra available for hydroxy-aromatics would be inadequate for comparative purposes when dealing with the wide range of compounds present in coal tar; therefore, compiling a catalog of spectra was begun as a continuing part of the tar program. Because these spectra should be valuable to other investigators in this and related fields, they are being presented in these reports. ***W. Beckering and W. W. Fowkes.*** *U. S. Bureau of Mines Report of Investigations* 5806, 1961, 34 pp. (TN21 Un3r Room 290)

* **Trimeric Aldoketenes.** While ketenes in polymerization give uniform dimeric compounds, continuous polymerization of aldoketenes results in new uniform trimers. Only a slight amount of dimeric products is formed in addition, the structure of which is analogous to diketenes. On the basis of the mode of formation, the degradating reactions and the comparison of the IR spectra of dimeric and trimeric aldoketenes, it could be proven that the latter have a structure of dialkyl cyclobutenolon acylates. Dimeric aldoketenes showing a dialkyl butenolon structure are found as an intermediate stage. This fact could be established by their reaction with ketenes and diethyl ketenes, yielding mixed trimers. Aldoketenes alone are capable of forming trimetric compounds. (*In German.*) Trimere Aldoketene. ***E. Enk and H. Spes.*** *Angewandte Chemie,* v. 73, no. 10, May 21, 1961, p. 334-338.

Air Oxidation of Resin Acids. III. The Photosensitized Oxidation of Neoabietic Acid and the Configurations of the Pine Gum Resin Acids. The photosensitized oxidation of the exo, endo transoid diene, neoabietic acid, was found to yield a crystalline diperoxide; analytical and chemical evidence indicate the structure to be 18-hydroperoxy-6,14-peroxy-$\Delta^{7(8)}$-dihydroabietic acid. Pimaric, isopimaric, and dehydroabietic acids were found to be unreactive. A transition state is proposed which appears to accommodate many of the known facts regarding the photosensitized oxidation of olefins. Data are cited to suggest the configurations for all asymmetric centers in palustric acid, and for the C-13-hydrogen atom in levopimaric acid. The conclusion is drawn that all seven of the major pine gum resin acids contain the same absolute configurations in the "asymmetric backbone chain" with the exception of the C-13-hydrogen atom in isopimaric acid. ***Walter H. Schuller and Ray V. Lawrence.*** *American Chemical Society, Journal,* v. 83, June 5, 1961, p. 2563-2570.

a **Fluorocarbon Halosulfates and a New Route to Fluorocarbon Acids and Derivatives. I. Polyfluoroalkyl Chlorosulfates.** The physical and chemical properties of $C_3F_7OSO_2Cl$, $C_3F_7[CF_2CF(CF_3)]_4[CF_2CF_2]nOSO_2Cl$, $C_2F_5CF(CF_3)[CH_2CF_2]_3OSO_2Cl$, and similar chlorosulfates are presented. The mechanism of chlorosulfate formation is discussed. Convenient one-step syntheses of carboxylic acids and derivatives from these chlorosulfates have been accomplished. ***Murray Hauptschein and Milton Braid.*** *American Chemical Society, Journal,* v. 83, June 5, 1961, p. 2500-2505.

b * **Conjugate Additions of Grignard Reagents to Alpha, Beta-Unsaturated Esters. VIII. Further Studies on the Effect of Cuprous Chloride. IX. 1,4- and 1,6-Additions of *n*-Butylmagnesium Bromide to the *sec*-Butyl Ester of Sobric Acid. X. Possible Influence of the Halogen in the Grignard Reagent.** VIII, X. ***Jon Munch-Petersen and Viggo Køgs Andersen;*** IX. ***Jon Munch-Petersen, et al.*** *Acta Chemica Scandinavica,* v. 15, no. 2, 1961, p. 271-299.

c * **Synthesis in the Field of Nitramine. II. Nitrolysis of the Alkylhexaminium Salts.** Nitrolysis of these salts in the nitric acid acetane hydride was used in preparing compounds of 1-alkyl-5-acetoxymethyl-1,3,5-trinitrotriazapentane and their 5-nitroxymethyl derivatives in the nitric acid-nitrogen pentoxide medium. The alkylation of the methylhexaminum salts to dimethylhexaminium salts as well as their nitrolysis were studied. (*In German.*) Synthesen auf dem Gebiet der Nitramine. II. Über die Nitrolyse der Alkylhexaminiumsalze. ***J. Denkstein and V. Kadeřábek.*** *Collection of Czechoslovak Chemical Communications,* v. 26, no. 5, May 1961, p. 1373-1379.

d **Some Effects of Boron Lewis Acids Upon Methyltin Compounds.** The salt $NaSn(CH_3)_3$ in liquid ammonia reacts with $H_3NB(CH_3)_3$ in such a manner that yields of $Sn_2(CH_3)_6$ above 90% are obtained upon warming to room temperature. However, when $NaSn(CH_3)_3$ reacts with BF_3 or $(CH_3)_2BF$ in diethyl ether, the yields of $Sn_2(CH_3)_6$ are far smaller. The main reason is found in the catalytic disproportionation of $Sn_2(CH_3)_6$ by these Lewis acids, producing methyltin polymers and tetramethyltin; then BF_3 reacts with the latter to make CH_3BF_2 and the new compound $(CH_3)_3SnBF_4$ (m.p. 89°; dissociable with liberation of BF_3). The decomposition of $(CH_3)_3SnH$ to H_2 and $Sn_2(CH_3)_6$ is catalyzed by diborane, which also is an effective catalyst for the disproportionation of $Sn_2(CH_3)_6$. ***Anton B. Burg and John R. Spielman.*** *American Chemical Society, Journal,* v. 83, June 20, 1961, p. 2667-2668.

e * **The Transformation of Cyclohexane Over a Cobalt Oxide-Molybdenum Oxide Bauxite Catalyst and Over a Nickel Sulfide-Tungsten Sulfide Catalyst.** The dehydrating effect of the desulfurizing catalysts is important during desulfurizing of napthene-containing oil fractions, especially when the "autofining" method is used. (*In German.*) Die Umwandlungen von Cyclohexan über einem Kobaltoxyd-Molybdänoxyd-Bauxit- und einem Nickelsulfid-Wolframsulfid-Katalysator. ***W. J. Hendriks, J. C. Vlugter, H. I. Waterman, and W. J. van de Weerdt.*** *Brenstoff-Chemie,* v. 42, no. 6, June 1961, p. 185-191.

f * **A Contribution to the Study of Mesohydroanthracene Compounds.** Describes syntheses starting from dibromo-9,10-dihydro-9,10-anthracene and from bis(chloromethyl)-9,10-anthracene, and studies condensations on disodium and dilithium mesodihydroanthracene derivatives as well as syntheses on the basis of the mesodihydroanthracene dicarboxylic diacides. (*In French.*) Contribution a l'étude de composés mésodihydroanthracéniques. ***Pierre Berçot.*** *Annales de Chimie,* v. 6, Mar.-Apr. 1961, p. 193-244.

g **A New Coloring Reaction on Thiosulfates.** Thiosulfates like some halide salts and thiocarbamides give a blue coloring reaction with o-tolidine and Cu salts. Tetrathionates give no reaction of this type and do not seem to disturb the thiosulfate detection to a large extent. (*In German.*) Über eine neue Farbreaktion auf Thiosulfate. ***Gustav Nilsson.*** *Zeitschrift für Analytische Chemie,* v. 182, no. 1, 1961, p. 24-26.

Amine Derivatives of Vanadium and Niobium Pentafluorides. The reactions of vanadium pentafluoride with ammonia, pyridine and ethylenediamine produce amminotetrafluorovanadium (IV), pyridinetetrafluorovanadium (IV) and tris(ethylenediamine)tetrafluorovanadium (IV) respectively. Niobium pentafluoride reacts with ammonia and ethylenediamine to give diamminopentafluoroniobium (V) and a product of composition $NbF_5(en)_{1.6}$. The infrared spectra of these new compounds are discussed and the reasons for the production of these compounds are considered in terms of maximum co-ordination state and fluorine-bridge bonding. ***R. G. Cavell and H. C. Clark.*** *Journal of Inorganic and Nuclear Chemistry*, v. 17, nos. 3-4, June 1961, p. 257-264.

* **Esters and Ethers of Polyaldehydes.** End groups of the polyaldehydes were identified by inspection of their infrared spectra. Aldehyde polymers with modified end groups show a substantially improved stability over the base polymer. ***O. Vogl.*** *Chemistry & Industry*, 1961, no. 22, June 3, p. 748-749.

Physical Methods in Organic Chemistry. I. Practical Techniques. This review article discusses chromatography, zone refining, countercurrent distribution, electrode processes, colorimetric analysis, and mass spectrometry. ***A. R. Pinder,*** *Chemistry & Industry*, 1961, no. 23, June 10, p. 758-770.

* **Studies on Elimination. I. The Formation of Olefins by Decomposition of β-Ketoesters.** Acetoacetates have been prepared by reacting diketene with three l-alkylcyclohexanols and an alkylcyclohexylcarbinol in the presence of catalytic amounts of sodium acetate. Decomposition of the β-ketoesters in the presence of *p*-toluenesulphonic acid and at the temperatures mentioned in Table 1 gives carbon dioxide, acetone and a mixture of olefins, which was analyzed by gas chromatography. In two cases, a primary and a secondary hydrogen were removed rather than a tertiary one, so that the thermodynamically more stable olefins are formed. ***Christer Frisell and Sven-Olov Lawesson.*** *Arkiv för Kemi*, v. 17, no. 5, 1961, p. 401-408.

* **Spectroscopic Study of Photolysis of Toluene in Rigid Solution at 77°K.** Examines the photolysis of toluene in this type of solution by absorption spectroscopy and luminescence. A substituted triene and benzyl radicals are formed. These radicals when heated react with O and form benzaldehyde. The mechanism of formation of benzaldehyde by photolysis of crystals of toluene at a low temperature is discussed. (*In French.*) Étude spectroscopique de la photolyse du toluéne en solution rigide à 77°K. ***Lydie Grajcar and Sydney Leach.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, v. 252, no. 23, June 5, 1961, p. 3577-3579.

CHEMISTRY—PHYSICAL (ORGANIC AND INORGANIC)

* **The Vibrational Structure of Electronic Spectra of Uranyl Nitrate. I. Force Constants and U-O Distances in Organic Solvents. II. The Dissociation Energy of Uranyl Ion. III. Transition Intensities in the Spectra of Uranyl Nitrate.** (*In Polish.*) Struktura oscylacyjna widm elektronowych azotanu uranylu. I. Stałe siłowe i odległosci U-O w rozpuszczalnikach organicznych. II. Energia dysocjacji jonu uranylowego. III. Intensywnosci przejsc w widmach azotanu uranylu. ***Adam Bartecki and Bogusława Jeżowska-Trzebiatowska.*** *Nukleonika*, v. 6, no. 4, 1961, p. 267-294.

* **Nuclear Magnetic Resonance Study of the Autoassociation and of the Intermolecular π-Effect of Some Amines.** A study of the proton of NH of different aromatic or aliphatic amines showed that the autoassociation of the derivatives of aniline is very low; that the NH grouping of the amines studied is sensitive to the intermolecular π-effect because of the circulation of the π-electrons in the case of benzene, pyrrol, etc. The special cases of N-methylaniline, orthotoluidine and allylamine were examined. (*In French.*) Étude par résonance magnétique nucléaire de l'autoassociation et des effets π intermoléculaires de quelques amines. ***Claude Giessner-Prettre.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, v. 252, no. 21, May 24, 1961, p. 3238-3240.

a • * **Co-Ordination of the NO Group.** The evidence indicates that nitric oxide normally coordinates as a charged ion. Complexes containing the neutral molecule such as $[Fe^{II}(CN)_5NO]^{n-}$, derived from the compound sodium pentacyanoammine ferrate^{II} which is widely used in analytical chemistry and in which the odd electron is still localized on the ligand, exist as unstable, transient compounds only. ***D. J. Morgan.*** *Talanta*, v. 3, no. 2, Dec. 1959, p. 113-117.

b • **Kinetics of the Thermal Decomposition of 1.1 Dichlorethane.** The speed of decomposition was measured between 641 and 723 K by a static method. Within this range of temperature, 1.1 dichlorethane decomposes in a rapid homogeneous reaction of the first order into vinyl chloride, hydrogen chloride and negligible amounts of acetylene. Measurement reveals an activation energy of 53.5 ± 0.8 k cal/mol. The speed constants are independent of the initial pressure of the substance under decomposition between 150 and 410 lmmHg. (*In German.*) Die Kinetik des thermischen Zerfalls von 1,1-Dichloräthan. ***H. Hartmann, H. Heydtmann, and G. Rinck.*** *Zeitschrift für Physikalische Chemie* (Frankfurt), v. 28, nos. 1-2, Apr. 1961, p. 71-84.

c • * **The Electronic Spectra of Acetophenones Substituted in the Methyl Group.** The ultraviolet spectra of a series of substances $C_6H_5CO.X$, and of the corresponding ions $C_6H_5CO{+}H.X$ where these were obtainable, have been determined [X=H, CH_3, C_2H_5, $C(CH_3)_3$, C_6H_5, CH_2OH, $CH_2N{+}H_3$, CH_2CN, CH_2Cl, CH_2Br, CH_2I, $CHCl_2$, $CHBr_2$, CCl_3, CBr_3]. Both polarity and steric effects of *X* influence the spectrum somewhat. However, the most prominent effect observed on the high-intensity band (at 2408 Å in benzaldehyde) is a displacement to longer wavelengths which increases with the general polarizability of *X* and which, in favorable cases, amounts to 200-300 Å. ***E. Spinner and A. Burawoy.*** *Spectrochimica Acta*, v. 17, no. 5, May 1961, p. 558-567.

d • * **The Ultra-Violet Spectra of Some *p*-Substituted Anisoles—Intramolecular Cohesive Forces and Electronic Spectra.** ***E. Spinner.*** *Spectrochimica Acta*, v. 17, no. 5, May 1961, p. 545-557.

e • * **The Structure of Protonated Amides and Ureas and Their Thio Analogues.** The electronic absorption spectra were studied of protonated thioamides and thioureas, as well as the infrared spectra of alkylated acetamide, thioacetamide, urea and thiourea and their hydrochlorides. All results consistently show that the proton is normally attached to the oxygen (or sulfur) atom. Earlier data pointing to the existence of the ammonium structure are reinterpreted. The resonance within these molecules appears to be the decisive factor in determining the site of protonation. ***M. J. Janssen.*** *Spectrochimica Acta*, v. 17, no. 5, May 1961, p. 475-485.

f • * **Luminescence Spectra From High-Frequency Excitation. I. The Spectra of Some Inorganic Gases.** A high-frequency generator is described which is capable of exciting "Tesla-type" luminescence in inorganic and organic gases and vapors at low pressures. New apparatus and a new method of examining the spectra are described. The results of investigations on air, oxygen, carbon dioxide, sulfur dioxide, nitrogen and argon are presented and discussed. ***Thomas Given, Robert J. Magee, and Cecil L. Wilson.*** *Talanta*, v. 3, no. 2, Dec. 1959, p. 191-199 + 2 plates.

g • **Kinetics of the Formation of Alkyl Hydrazines From Chloramine and Alkyl Amines in Liquid Ammonia.** Reaction-rate constants have been determined conductimetrically in liquid ammonia at −75,−67,−60, and−50°. ***Francis Nash Collier, Jr., William W. Horner, Paul M. Dickens, James G. Hull, and W. T. Layton.*** *American Chemical Society, Journal*, v. 83, May 20, 1961, p. 2235-2238.

h • * **Adhesion Pressure in the Diffusion Theory of Polymer Adhesion.** An approximate quantitative treatment of the Voyutskiĭ diffusion theory of adhesion has been presented. The adhesive strength (adhesion pressure) is proportional to the quantity of the end groups of the adhesive macromolecules diffusing into the substrate and to the depth of their penetration. For chemically similar polymers the proportionality factor is equal to the resistance force arising in the motion of a singular group of atoms among those of the same species. The quantity of macromolecular end groups per unit surface area

is determined by the molecular weight and density of the polymers and the depth of penetration by the chemical nature of the latter, their physical state and the time of contact. The adhesive strength has been found to be directly proportional to the 2/3 degree of the number of effective branches of the molecule, inversely proportional to the 2/3 degree of the molecular weight of the polymer and directly proportional to the pulling-off rate. It changes with time according to a parabolic law. (*In Russian.*) Davlenie prilipaniia v diffuzionnoi teorii adgezii polimerov. ***R. M. Vasenin.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 679-685.

* **Effect of the Structure of Titanium Chloride Upon the Stereospecificity of Complex Catalysts. II. Changes in the Structure and Catalytic Properties of Titanium Trichloride on Thermal Treatment.** Changes in the structure and catalytic properties of $TiCl_3$ during thermal treatment were investigated by electron microscopic, X-ray and chemical methods. It has been found that heating for two hours at 300-400° in vacuum completely transforms β-$TiCl_3$ to the α-form; formation of the γ-compound was not observed. The transformation occurs gradually. The beginning of the α-conversion and the width of the transition temperature range depends upon the conditions of preparation of β-$TiCl_3$, β-$TiCl_3$ and α-form obtained from β-$TiCl_3$ possess a large specific surface area, which explains their high catalytic activity. On the example of propylene polymerization it has been shown that the stereospecificity of the catalyst $TiCl_3 + Al(C_2H_5)_3$ increases monotonously with increasing α-$TiCl_3$ content of the preparation. (*In Russian.*) Vliianie struktury trekhkhloristogo titana na stereospetsifichnost kompleksnykh katalizatorov. Izuchenie izmeneniia struktury i kataliticheskikh svoistv trekhkhloristogo titana pri termicheskoi obrabotke. ***A. A. Korotkov and Li Tszun-chan.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 691-698.

* **Effect of the Structure of Titanium Trichloride Upon the Stereospecificity of Complex Catalysts. I. Effect of the Conditions of Preparation of β-$TiCl_3$+$Al(C_2H_5)_3$ Catalysts on Their Stereospecificity in Propylene Polymerization.** The stereospecificity of β-$TiCl_3$+$Al(C_2H_5)_3$ catalysts with respect to the method of preparation of β-$TiCl_3$ has been investigated. It has been established on the example of propylene polymerization that the conditions of preparation of β-$TiCl_3$ from $TiCl_4$ and $Al(C_2H_5)_2Cl$ (reaction temperature, concentration and order of mixing of the reagents) leading to changes in dispersity and crystal defects, while affecting the activity of the catalyst have little bearing on its stereospecificity. (*In Russian.*) Vliianie struktury trekhkhloristogo titana na stereospetsifichnost kompleksnykh katalizatorov. I. Vliianie uslovii prigotovleniia katalizatorov na osnove β-$TiCl_3$+$Al(C_2H_5)_3$ na ikh stereospetsifichnost pri polimerizatsii propilena. ***A. A. Korotkov and Li Tsun-chan.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 686-690.

* **Static Surface Tension of Gelatine Solutions.** The static surface tension of gelatine solutions at the boundary with vapor has been determined by the sessile drop (bubble) method. The kinetics of change of surface tension indicate prolonged formation of the surface layer for various gelatine concentrations and pH values of the medium. A minimum value of surface tension occurs at the isoelectric point and a maximum at pH-3. The dependence of the surface tension of gelatine solutions upon the pH has been discussed in terms of globular-fibrillar transitions. (*In Russian.*) Staticheskoe poverkhnostnoe natiazhenie rastvorov zhelatiny. ***V. A. Pchelin and R. A. Kul'man.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 768-774.

* **Polarographic Reduction of Triethyl Lead Hydroxide.** The polarographic behavior of this hydroxide was studied in buffer solutions within a wide range of concentration of the H ions in neutral salt and alkali solutions. The reduction of the hydroxide on a Hg drop cathode occurs through the formation of a free radical $(C_2H_5)_3Pb$. (*In Russian.*) Poliarograficheskoe vosstanovlenie gidrookisi trietilsvintsa. ***I. A. Korshunov and N. I. Maliugina.*** *Zhurnal Obshcheĭ Khimii,* v. 31(93), no. 4, Apr. 1961, p. 1062-1067.

* **Polarographic Determination of Dimercapto Propyl Phthalamide Acid.** Studies the catalytic effect of this acid and of its disulfide derivative in $CoCl_3$ or $[Co(NH_3)_6]Cl_3$-buffer

solutions in the presence of a 0.01% gelatine addition. The acid studied has a more intense catalytic effect than its derivative. The catalytic stage increases linearly with the concentration of the acid in Co(II) salt solutions and in Co(III) salt solutions. The polarographic determination is most sensitive in the Co(II) buffer. (*In German.*) Über die Polarographische Bestimmung der Dimercaptopropylphthalamidsäure. ***A. Contrea, Gh. Ciuhandu, and M. Rocsin.*** *Acta Chimica Academiae Scientiarum Hungaricae,* v. 27, nos. 1-4, 1961, p. 99-103.

* **Using Membrane Electrodes in the Investigation of Ion Concentrations.** Membrane electrodes were prepared from silver iodide and paraffin, and used in examining the activity of iodide and silver ions within a 10^{-1}-10^{-6} m/l range of concentration. The conditions for suitable operation of the membranes were studied. A relation between the electrode function and conductivity was indicated, and a theoretical formula derived for the potential. (*In German.*) Über die Anwendung von Membranelektroden bei der Untersuchung von Ionenkonzentrationen. ***E. Pungor and E. Hollós-Rokosinyi.*** *Acta Chimica Academiae Scientiarum Hungaricae,* v. 27, nos. 1-4, 1961, p. 63-68.

* **Hydration of a Triple Bond With the Aid of Mercury Ions Deposited on Cationites, and Mechanism of the Reaction.** Hydration of acetylene and acetylene alcohols with the help of cationites with deposition on them of bivalent Hg ions in aqueous medium was obtained. The catalyst is analogous to the Kucherov catalyst and loses its activity with time. The catalyst of hydration of the triple bond is the divalent Hg ion. (*In Russian.*) Gidratatsiia troĭnoĭ sviazi s pomoshch'iu ionov rtuti, osazhdennykh na kationtakh, i mekhanizm reaktsii. ***S. A. Vartanian, S. K. Pirenian, and N. G. Nanasian.*** *Zhurnal Obshcheĭ Khimii,* v. 31(93), no. 4, Apr. 1961, p. 1269-1272.

Remote Attack and Ester Hydrolysis on Electron Transfer. The electron transfer reaction between Cr^{++}aq. and $(NH_3)_5CoL^{++}$ (where L is the phenyl or methyl half ester of fumaric or terephthalic acid) takes place through attack by the reductant at the carboxyl group remote from the cobalt center. Ester hydrolysis occurs, and the alcohol is found associated with the Cr(III) complex after reaction. ***R. T. M. Fraser and H. Taube.*** *American Chemical Society, Journal,* v. 83, May 20, 1961, p. 2239-2242.

* **Gas Chromatography Investigations of Nonreduced Iron Catalysts (α-Fe_2O_3).** Four iron(III) oxides of different K_2CO_3 contents were tested. The heats of absorption of propane and buthane and the surface of the oxides were calculated. A comparison of the surface determination by gas chromatography revealed that a part of the micropores of the α-Fe_2O_3 is blocked by K_2CO_3. Low K_2CO_3 additions ($<0.8\%$) have no blocking effect and cause a surface enlargement probably due to the prevention of recrystallization mechanisms of α-Fe_2O_3 by K_2CO_3. (*In German.*) Gaschromatographische Untersuchungen an unreduzierten Eisen-Katalysatoren (α-Fe_2O_3). ***G. M. Leuteritz.*** *Brennstoff-Chemie,* v. 42, no. 5, May 1961, p. 154-156.

Effect of Inert-Gas Moderators on the (n, γ)-Activated Reaction of I^{128} with CH_4. In the presence of a large excess of gaseous methane 54.4 ± 0.5% of I^{128} formed by (n, γ) activation was found to become stabilized in organic combination. The effects of inert-gas additives in moderating the reaction of I^{128} with CH_4 were determined in an effort to ascertain the mechanism. ***Edward P. Rack and Adon A. Gordus.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 1855-1860.

Quantum Mechanics of Mobile Electrons in Conjugated Bond Systems. I. General Analysis in the Tight-Binding Formulation. II. Augmented Tight-Binding Formulation. III. Topological Matrix as Generatrix of Bond Orders. IV. Integral Formulas. V. Empirical Determination of Integrals Between Carbon Atomic Orbitals From Experimental Data on Benzene. VI. Theoretical Evaluation of Energy Contributions. I-IV, VI. ***Klaus Ruedenberg.*** V. ***Klaus Ruedenberg and E. Miller Layton, Jr.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 1861-1913.

Interaction of Hydrogen and of Nitrogen With a Molybdenum Ribbon. Adsorption and desorption studies—by flash-filament and ion gage techniques—gave information on surface coverages, sticking probabilities, atom formation, and surface mobilities for the interaction of gases with a molybdenum

ribbon. ***R. A. Pasternak and Hans U. D. Wiesendanger.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 2062-2068.

Uranium Ion Self-Diffusion in UO_2. Diffusion coefficient measurements for uranium (U^{+4}) in stoichiometric UO_2 were determined by means of the surface activity decrease method. Uranium diffusion in the temperature range 1450-1785 C can be represented by the equation $D = 4.3 \times 10^{-4} \exp(-88{,}000/RT)$ cm^2/sec. ***A. B. Auskern and J. Belle.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 311-319.

The Effects of Radiation on the Tantalum-Tantalum Oxide Electrode. The Ta/Ta_2O_5 electrolyte system, when irradiated with γ rays or electrons, has been studied in detail. The results are compared with those previously reported for irradiation with UV and X-rays. ***F. S. Feates and B. Knight.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 277-283.

Oxygen Ion Self-Diffusion in Uranium Dioxide. By means of the isotopic exchange reaction between uranium dioxide powders of normal oxygen-18 content and carbon dioxide gas enriched in oxygen-18, the self diffusion of oxygen in stoichiometric and nonstoichiometric uranium dioxide has been measured. ***A. B. Auskern and J. Belle.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar-Apr. 1961, p. 267-276.

Theory of Solutions. III. Thermodynamics of Aggregation or Polymerization. ***Terrell L. Hill.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 1974-1982.

On the Theory of Helix-Coil Transition in Polypeptides. The evaluation of the configurational partition function of a polypeptide molecule, with the internal rotation angles as variables, leads to an improved treatment of the phenomenon of helix-coil transition in polypeptide molecules. The conditional probabilities of occurrence of helical and coiled states of the peptide units are obtained in the form of a 3 x 3 matrix. Explicit formulas are given for the degree of intramolecular hydrogen bonding, average number of helical sequences, and the distribution of their lengths, as well as the number average and the weight average of these lengths. ***Shneior Lifson and A. Roig.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 1963-1974.

Positive and Negative Ion Formation in CCl_3F. A mass spectrometer with an ion source utilizing nearly monoenergetic electrons was used to measure appearance potentials of positive and negative ions in CCl_3F. Kinetic energy measurements were made on the negative ions. The results have lead to values for the ionization potentials of CCl_3, CCl_2F, and CClF. The C–F and C–Cl bond energies have been determined from measurements on the negative fluorine and chlorine ions. A value is given for the electron affinity of the CCl_3 radical. ***R. K. Curran.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 2007-2010.

Effect of Electron Energy on Some Electron-Impact Processes. Decomposition processes induced by electron impact have been inferred from appearance potentials and from isotopic distributions of fragment ions in mass spectra of labeled compounds. Implicit in such inferences is an assumption that the paths by which the fragment ions are formed are the same near the appropriate appearance potentials as at the higher electron energies usually employed. For five ions that were the subjects of earlier studies—$C_7H_7^+$ from two deuterated *p*-xylenes and $C_5H_5^+$ from two deuterated toluenes and a deuterated benzyl chloride—isotopic distribution has been found to be essentially independent of electron energy. These results support the assumption made in earlier studies. ***Seymour Meyerson.*** *Journal of Chemical Physics,* v. 34, June 1961, p. 2046-2049.

* **Dielectric Dispersion of Polar Liquids. V. Ethyl Cinnamate.** The dielectric properties of ethyl cinnamate at 18 different frequencies in the ultrahigh frequency region have been studied at two temperatures, viz. 33 C and 43 C. A comparison of the relative correctness of the Cole-Cole and Fuoss and Kirkwood functions for determining the distribution of relaxation times has been made. ***B. Lakshminarayana.*** *Journal of Scientific & Industrial Research,* v. 20B, Apr. 1961, p. 153-156.

* **Ultrasonic Velocities in Some Binary Mixtures of Benzyl Alcohol.** Studies have been carried out in liquid mixtures of benzyl alcohol with *n*-butyl alcohol, isobutyl alcohol, *sec*-butyl alcohol, *tert*-butyl alcohol, ethylene glycol, glycerol, cyclohexanol and phenol. The parameters, adiabatic compressibility and molar sound velocity have been calculated for liquid mixtures and it has been found that the molar sound velocity varies linearly with molar fraction in spite of the non-linear variations in the velocity and density in some of the mixtures. The variation of velocity and adiabatic compressibility are explained on the basis of intermolecular forces. ***H. S. Rama Rao and B. Ramachandra Rao.*** *Journal of Scientific & Industrial Research,* v. 20B, Apr. 1961, p. 157-160.

The Relative Humidity Provided by Saturated Solutions of Ammonium Nitrate. Linear relation between log r.h. and log mole proportion of water in a saturated solution is developed and applied to data for the relative humidity of the saturated solution of ammonium nitrate over a range of temperatures. The data are also smoothed by direct linear relations between relative humidity and temperature. The results by the two methods agree closely and are believed to give the r.h. of this saturated solution to within 0.2%. ***G. E. Collins.*** *Research Applied in Industry,* v. 14, June 1961, p. 247-257.

Comprehensive Study of the Ion Pumping of the Noble Gases. Employing an ultra-high-vacuum system which could be operated statically or dynamically. The dependence of the important pumping parameters, initial pumping speed and maximum quantity of gas pumpable, upon gas composition, electrode potentials and gage temperature have been investigated. The relationship between instantaneous pumping speed and the quantity of gas pumped has been deduced, and observations upon the recovery of gas, following sorption, at ambient and elevated temperatures has also been made. ***B. Cobic, G. Carter, and J. H. Leck,*** *British Journal of Applied Physics,* v. 12, June 1961, p. 288-292.

COATINGS

* **The Evaluation of Priming Paints by Corrosion Tests.** A study has been made of the reproducibility and relative severity of four laboratory corrosion tests for evaluation of priming paints, and of their correlation with outdoor exposure tests. The tests comprised the Humidity Test described in Method No. 25 of the United Kingdom Defence Specification DEF.1053, the A.S.T.M. Salt Fog Test, Method No. B117-54T, a test similar to the A.R.E. Salt Droplet Test described in B.S.1391-1952, and a Salt Spray Test similar to that described in Method No. 24 of DEF.1053. Each test was conducted for 96 and 240 hr. ***J. R. Rischbieth and K. R. Bussell.*** *Oil & Colour Chemists' Association, Journal,* v. 44, June 1961, p. 367-376.

* **Epoxy- and Episulphido-Compounds in the Field of Fats I: The Literature on Epoxy Fatty Acids and Their Use in the Synthesis of Hydroxy-Amino Fatty Acids.** (*In German.*) Epoxy- und Episulfido-Verbindungen auf dem Fettgebiet I: Das Schrifttum über Epoxy-Fettsäuren und ihre Verwendung zur Synthese von Hydroxy-amino-Fettsäuren. ***H. P. Kaufmann, G. Hauschild, and R. Schickel.*** *Fette, Seifen, Anstrichmittel,* v. 63, no. 3, Mar. 1961, p. 239-250.

Wire Insulating by the Fluidized Bed Process. This method of coating is relatively in its infancy as far as the technology of powder formulation, manufacture and application are concerned. ***C. A. Brown.*** *Wire and Wire Products,* v. 36, June 1961, p. 750-752.

* **Aluminium Sprayed Steel in Marine Conditions.** Only in the last year or two has sufficient information become available to confirm the high durability of Al coatings in marine conditions. With zinc spray, however, useful data were available early by comparison with the behavior of galvanized coatings, already well established in industry. ***F. C. Porter.*** *Engineer,* v. 211, June 2, 1961, p. 906-907.

Anticorrosive and Marine Paints. Includes metal pretreatment, Zn dust paints, inhibitive pigments, and antifouling paints. ***R. H. Chandler,*** *Paint Manufacture,* v. 31, June 1961, p. 214-216.

Factors Affecting the Gloss of Emulsion Paints. Formidable problems confront the formulator of gloss emulsion paint if good flow, opacity, and freedom from tackiness are to be achieved. An investigation of some of the factors involved with particular reference to polyvinyl acetate dispersions. ***J. Wood and P. J. Fry.*** *Paint Manufacture,* v. 31, June 1961, p. 199-205.

Protective Properties of Vacuum Coatings. Present and Future Techniques. Coating process and basic equipment are discussed and an account is given of the properties and applications of commercially produced Al and Cd coatings. ***N. A. Lockington and I. J. Tóth.*** *Corrosion Technology,* v. 8, June 1961, p. 168-172.

Zinc Dust Paints—Chemical or Electrochemical Protection? Reviews English and subsequent German research into the mechanism of the protective action; the weight of evidence favors the chemical protection theory. ***R. H. Chandler.*** *Corrosion Technology,* v. 8, June 1961, p. 165-167.

* **Protection of Ships' Hulls.** *Corrosion Prevention & Control,* v. 8, June 1961, p. 56.

CONTROL SYSTEMS, COMPUTERS, AUTOMATION, CYBERNETICS, AND SYSTEMS ENGINEERING

Computers for the Chemical Engineer. Reviews the seven papers that were recently presented at a symposium which dealt with the application of computers in research, plant control and management. ***V. G. Jenson.*** *Industrial Chemist,* v. 37, June 1961, p. 267-270.

* **Electronic Control of Highway Vehicles.** Article describes the vehicle-control system at present being developed by RCA. ***L. E. Flory.*** *Institution of Electrical Engineers, Journal,* v. 7, no. 77, May 1961, p. 271-273.

BAND-1—A Data Reduction Program for the IBM-704. BAND-1 is an IBM-704 program to reduce the experimental data obtained from measurements of the neutron activation distribution within a critical facility. ***B. L. Anderson, A. P. Hemphill, P. H. Jarvis, and R. E. Kettler.*** *U. S. Atomic Energy Commission, WAPD-TM-216,* May 1961, 50 pp. (UF767 Un3.1wa Contin.)

Lectures on Communication System Theory. Purpose is to stimulate the development of modern approaches to the design and evaluation of new communication systems by defining a skeleton for the needed discipline and discussing most of the major unsolved problems. Discussions are theoretical, with emphasis on methods of applying mathematical models and techniques to the design, analysis, and evaluation of reliable systems. Criteria for evaluating system performance and comparing various systems; detailed descriptions of general channel models stemming from observed behavior of scatter, multipath, and meteor-trail transmission media and the nature of the problem in communicating through these media; an engineering tutorial presentation of mathematical characterizations of signals and disturbances, formulation of statistical decision rules, signal selection, and coding and decoding problems; and discussions of new communication systems in the light of background provided in the above areas. ***Elie J. Baghdady, editor.*** 617 pp. 1961. McGraw-Hill Book Co., New York. (TK6543 B14L)

Radar-Computer Display Traces Alphanumeric Characters. A new high-resolution computer output display, the calliscope or calligraphic oscilloscope, is in operation with the CG-24 computer at the M.I.T. Millstone Hill radar site. ***Kenneth E. Perry and Everett J. Aho.*** *Electronics,* v. 34, no. 26, June 30, 1961, p. 75-79.

Cryotron Computers Approaching Reality But Production Problems Still Remain. ***George V. Novotny.*** *Electronics,* v. 34, no. 26, June 30, 1961, p. 26-27.

* **Developing Control Systems for Automated Equipment.** The systems approach is applied to integrate individual process stages into an over-all control data system. Such integrated systems make possible both improvement and management cost control. ***Henry R. Chope.*** *Automation,* v. 8, July 1961, p. 76-82.

a * **Survey Report and Forecast on Automation Trends.** ***Roger W. Bolz.*** *Automation,* v. 8, July 1961, p. 35-50.

Nimbus Uses Wheels, Jets for Control. The proposed control system for stability of the Nimbus polar orbit satellite is outlined. Reactor wheels and jets are used to orient and stabilize the satellite in all three axes. ***George Alexander.*** *Aviation Week and Space Technology,* v. 75, July 10, 1961, p. 77 + 1 page.

b **Using Electro-Hydraulic Servo Controls.** Miniature high-performance servo-valves designed for aircraft and guided weapon projects are now finding wide use in control applications generally. *Engineering,* v. 191, June 16, 1961, p. 818-819.

c **Data-Bloc and Data-Pac Symbolic Logic.** Logic building blocks in two package styles (Data-Bloc and Data-Pac) permit rapid breadboarding. The families are electrically equivalent and interchangeable. Data-Bloc modules, designed for rapid breadboarding, feature a logic diagram on the front panel. When the breadboard is accomplished, they can be replaced rapidly with the Data-Pac electrical equivalents to produce a final system. ***George Engman.*** *Instruments and Control Systems,* v. 34, June 1961, p. 1052-1054.

d **Telemetric Control and Communication.** The equipment costs, possibilities of expansion, growth of the system, flexibility of the system and other factors influencing the design of telemetric control. ***George A. Haninger.*** *Instruments and Control Systems,* v. 34, June 1961, p. 1071-1076.

e * **The Application of Automatic Controls to Oil Burner Installations.** Concludes with a set of tables from which it is possible to select an oil burning installation and read off a list of the items necessary for a specified control system. ***F. B. Rider.*** *Institution of Heating and Ventilating Engineers,* v. 29, June 1961, p. 80-94.

f * **Computer Simulation of Human Thinking and Problem Solving.** Reviews the several latest possibilities. ***Herbert A. Simon and Allen Newell.*** *Datamation,* v. 7, no. 6, June 1961, p. 18-20.

* **An Approach to On-Line Processing.** ***Sherman C. Blumenthal.*** *Datamation,* v. 7, no. 6, June 1961, p. 23-24.

g * **The Use of Punch Cards in Different Services of an Industrial Enterprise.** Studies the services rendered by a punch card equipment to an average industrial concern and surveys the organization of this punch card system, its application to the different sections connected with the administration of the personnel, the material inventory, the calculation of costs and the launching and programming of production. (*In Spanish.*) Aplicación de fichas perforadas a distintos servicios de una empresa industrial. ***Ramón Boixadós Malé.*** *Acero y Energía,* v. 18, no. 104, Mar.-Apr. 1961, p. 47-53.

h **Computer Control at American Oil. I. Application to the Process Unit.** A 140,000 bbl./day crude-distillation is tied in with an IBM 704 computer at a Whiting, Indiana, refinery. Here are details in depth. ***R. H. Crowther, J. E. Pitrak, and E. N. Ply.*** *Chemical Engineering Progress,* v. 57, June 1961, p. 39-43.

i **Computer Control. III. The Computer Systems.** The general purpose computer is the central component of the system. Final stage will be conducted with special purpose control computer for adjusting process unit instruments. ***A. D. Pendleton.*** *Chemical Engineering Progress,* v. 57, June 1961, p. 48-50.

j **Random Pulse Generator Tests Circuits, Encodes Messages.** Shift-register generator uses high-speed logic in producing complicated pulse sequences up to four billion bits in length. Generator is used in tests that determine error rates of data-transmission systems and in high-security communication links where it produces an undecipherable and nonrepetitive modulating waveform. ***B. K. Ericksen and J. D. Schmidt.*** *Electronics,* v. 34, no. 25, June 23, 1961, p. 56-59.

k **Optimization of Process Performance.** The control system is taken to consist of the process to be optimized together with the interconnected digital computer. The control strategy is realized in the program of the digital computer. In the present

paper a number of such programs or algorithms are discussed for carrying out a search of the possible settings of the process input (independent) variables in such a way as to locate an extremal of the possible values of a chosen objective function. ***Leon Lapidus, Eugene Shapiro, Saul Shapiro, and R. E. Stillman.*** *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 288-294.

ELECTRICAL ENGINEERING

*** Effect of Bundle-Conductor Field Influence on EHV Transmission-Line Design.** A discussion of the corona and radio influence voltage generated from an extra high voltage transmission line. ***R. W. Harmon.*** *Power Apparatus and Systems*, 1961, no. 54, June, p. 316-326.

*** Evaluation of Generator Windings Based on In-Stator Single-Coil Power Factor Measurements.** The detection of faulty insulation, the grading and rewinding of old stator coils for further use and the economics associated with such a program, examples of troubles found in existing stocks of new coils, data on shellac-micafolium and asphalt-mica-tape coils, and additional developments pertaining to test technique and theory. ***R. G. A. Brearley, D. A. Findlay, and C. C. Louttit.*** *Power Apparatus and Systems*, 1961, no. 54, June, p. 226-240.

*** Detection of Incipient Faults in Transformers by Gas Analysis.** A discussion of the equipment and procedure for analysis and interpretation of the results. Examples of detecting faults are also presented. ***P. S. Pugh and H. H. Wagner.*** *Power Apparatus and Systems*, 1961, no. 54, June, p. 189-195.

*** Resistance and Capacitance Measurement on High-Voltage Insulation at Very-Low Frequencies.** The theoretical basis for making the measurements at as high a voltage stress as possible consistent with high-potential test practice. Description of a special bridge developed to make these measurements. ***B. V. Bhimani.*** *Power Apparatus and Systems*, 1961, no. 54, June, p. 155-169.

*** Field Tests of Lightning-Arrester Voltage and Current Caused by Switching a 220-Kv Line.** ***M. C. Galiyano, A. R. Hileman, C. L. Wagner, and V. C. Detty.*** *Power Apparatus and Systems*, 1961, no. 54, June, p. 128-141.

Outside-Coil Magnetic Head Improves High-Frequency Recording. Configuration permits smaller air gap, higher magnetic tape packing densities. ***Marvin Camras and Robert Sears.*** *Electronics*, v. 34, no. 26, June 30, 1961, p. 89-91.

*** Automating the Diesel Electric Utility.** A condensation of a paper in which design philosophy and details of the system are outlined to tell what is necessary for complete automation and how it was done in a plant with three different-sized engines. ***R. D. Hamilton.*** *Diesel and Gas Engine Progress*, v. 27, July 1961, p. 3032.

Electrical Safety Guide to Hazardous Process Areas. This report takes up the classification of areas by degree of hazard; the selection, installation and maintenance of the proper electrical equipment; and new trends in wiring methods and materials. ***Richard W. Scott.*** *Chemical Engineering*, v. 68, July 10, 1961, p. 123-138.

*** Use of Mixed Reference Axes in the Solution of Power Network Problems by the Tensorial Method.** It is possible to determine Z', the final impedance tensor, both in circuit and sequence axes even when the various components of Z, the primitive compound impedance tensor, are given in a mixed reference axis, i.e. some components being expressed in actual circuit axis and some in sequence axis, provided the different connection tensors in the compound C, C_t and C_i are known in the mixed reference axis in addition to the circuit and sequence axes. The application of the mixed reference axis in the calculation of Z', and hence in the solution of some compound power networks, has been illustrated with the help of examples. ***S. K. Basu.*** *Journal of Scientific & Industrial Research*, v. 20B, Apr. 1961, p. 137-144.

*** A Set of Standard Specifications for Linear Automatic Control Systems.** The specifications discussed fall naturally into three groups: frequency domain, time domain, and generalized performance indices. ***J. E. Gibson, et al.*** *Applications and Industry*, 1961, no. 54, May, p. 65-77.

ELECTROCHEMISTRY

The Pilot Plant Production of Electrolytic Uranium Dioxide. A fused salt electrolytic process is described. The electrolyte, containing uranyl chloride dissolved in molten NaCl/KCl eutectic, is obtained by the direct chlorination of uranium oxide *in situ* in the fused salt, and electrolysis between graphite electrodes forms a crystalline deposit of UO_2 at the cathode. The deposition is carried out with either horizontally or vertically disposed electrodes, but the latter are preferred from the point-of-view of simplicity. An alternative process, using uranium ore concentrate as the starting material, and involving three electrolytic stages, is also described. ***J. R. Chalkley.*** *Journal of the Less-Common Metals*, v. 3, no. 2, Apr. 1961, p. 98-109.

*** Electrochemical Properties of Some Anhydrous Hydrogen Chloride Solutions.** The conductivity and decompositon voltage of dichlorethane hydrogen chloride solutions were measured. Conductivity is observed only during the absorption of moisture, considerably changing in time. (*In Russian.*) Ob elektrokhimicheskikh svoĭstvakh nekotorykh nevodnykh rastvorov khloristogo vodoroda. ***N. G. Dorofeeva and O. K. Kudra.*** *Ukrainskiĭ Khimicheskiĭ Zhurnal*, v. 27, no. 3, 1961, p. 306-311.

Uranium Dioxide Single Crystals by Electrodeposition. Separate single crystals of uranium dioxide were obtained by the electrolysis of uranyl chloride in fused alkali metal chloride melts at potentials below the apparent decomposition potential for the reaction: $UO_2Cl_2 \rightarrow UO_2 + Cl_2$, and at low cathode current density. Electrolysis was carried out using a platinum cathode and a carbon anode. Uranium dioxide crystals of cubo-octahedral habit were grown on the cathode to a size of about 3 mm across and a mass of about 50 mg. A side reaction was observed which could be controlled to result in crystals at the cathode having compositions approximating to UO_2, U_4O_9 or U_3O_8. ***R. G. Robins.*** *Journal of Nuclear Materials*, v. 3, no. 3, Mar.-Apr. 1961, p. 294-301.

*** A New Thermionic Generator.** A thermionic generator capable of producing alternating current is described in this short account. ***D. Gabor.*** *Institution of Electrical Engineers, Journal*, v. 7, no. 77, May 1961, p. 287-288.

ELECTRONICS

*** Ferritic Valves With Reduced Sizes and Weight.** Describes the construction and electrical parameters of waveguide resonance valves (ferritic inserts) producing satisfactory matching (KCB$<$1.05) in the 15% wave range in the case of a small length, and usable in radiorelay link service and in measuring technique. (*In Russian.*) Ferritovye ventili s umen'shennymi gabaritami i vesom. ***S. S. Perel'muter.*** *Radiotekhnika*, v. 16, no. 6, June 1961, p. 34-37.

Low-Speed Time-Multiplexing With Magnetic Latching Relays. Discusses a multiplexing system designed specifically for low-speed operation and multiple-rate flexibility. A unique synthesis of the basic circuit provides for the time-multiplexing of *n*-measurements with *n*-1 magnetic latching relays. Assuming an external two-phase clocking source, no other components, active of passive, are required in the circuit. Other advantages of the circuit are: low-average power consumption, no additional monitoring or reset circuitry required to insure proper operation at turn-on or after momentary power failure, and the virtual impossibility of switching more than a single measurement to the common output line, even in the case of component or wiring failure. ***John F. Meyer.*** *IRE Transactions on Space Electronics and Telemetry*, v. SET-7, no. 2, June 1961, p. 34-41. (TK1 In6.6r Vis.)

Equations and Procedure for Designing Transistor or Zener Shunt Regulators. ***Melvin Beebe.*** *Electronics*, v. 34, no. 26, June 30, 1961, p. 92.

Testing Microwave Transmission Lines Using the Sampling Oscilloscope. Pulse-reflection technique uses sampling oscilloscope to make direct readings of characteristic im-

pedance. Discontinuities in impedance along line can be identified. ***Harley Halverson.*** *Electronics*, v. 34, no. 26, June 30, 1961, p. 86-88.

Four-Layer Diode Triggers High-Voltage Pulse Generator. Simple generator uses four-layer diode to discharge a capacitor. Lockout circuit prevents diode from remaining in the conducting state, allows 1-Kv output of 10,000 pulses per second. ***N. C. Hekimain and P. M. Schmitz.*** *Electronics*, v. 34, no. 26, June 30, 1961, p. 84-85.

Amplitude-Distribution Analyzer. Instrumentation to automatically record amplitude distribution curves is described. However, instead of modulating a pulse train with the studied signal, as done by Davenport, the described analyzer mixes the amplitude of a high-frequency sinusoid with the studied signal, producing greater stability and requiring less bandwidth. The amplitude is scanned by reducing the amplitude of the carrier sinusoid, while keeping the rms value of the studied signal constant. The distribution curves of a random noise sample and of two sinusoids, the latter of which are used in calibration of the amplitude axis, are presented. ***E. L. Pipkin.*** *Review of Scientific Instruments*, v. 32, June 1961, p. 670-673.

Electrical Activity of the Human Body. Life and electricity are closely related. Here is the nature of some of the signals that are generated within the body along with activity of heart, brain, and muscles. ***Ed Bukstein.*** *Electronics World*, v. 66, no. 2, Aug. 1961, p. 27 + 4 pages.

* **The Microcircuit Concept.** Outlines the different approaches to the microminiaturization of electronic circuits and components and deals with the application of the microminiature concept to an integrator for a missile. *Engineer*, v. 211, June 23, 1961, p. 1026-1027.

Thermal-Noise Errors in Simultaneous-Lobing and Conical-Scan Angle-Tracking Systems. Relationships for rms angular errors are developed for certain common active space probe and satellite angle-tracking systems. The only source of error considered is the thermal and shot noise of the receiver, bandlimited by the tracking servo noise bandwidth. If additional smoothing after angular readout is performed, only the special case of many samples averaged over a time long compared to the reciprocal servo noise bandwidth is considered. These thermal-noise errors are by no means the usual practical accuracy limitations of an angle-tracking system. They do, however, set bounds on minimal signal strength allowable for the desired tracking accuracy. The received signals were assumed to be sinusoidal of constant peak amplitude with the information, if any, contained in phase or frequency modulation. This is the most common signal in space probe or satellite tracking. ***Jean A. Develet, Jr.*** *IRE Transactions on Space Electronics and Telemetry*, v. SET-7, no. 2, June 1961, p. 42-51. (TK1 In6.6r Vis.)

* **Radio Interference From Ignition Systems.** Comparison of American, German, and British measuring equipment, techniques and limits. ***A. H. Ball and W. Nethercot.*** *Institution of Electrical Engineers, Proceedings*, v. 108, pt. B, no. 39, May 1961, p. 273-278.

* **Some Aspects of the Space Communication Problem.** ***R. Smelt.*** *Canadian Aeronautical Journal*, v. 7, no. 6, June 1961, p. 235-241.

Medical Electronics. IV. Prosthetics—Hearing Aids and Blind Guidance Devices. Here are some of the electronic aids helping overcome the tremendous handicap imposed on persons who are wholly or partially deprived of sight and hearing. ***William E. Bushor.*** *Electronics*, v. 34, no. 25, June 23, 1961, p. 43-49.

* **Microwave Properties of Polycrystalline Hybrid Garnets.** The microwave properties (magnetization, linewidth, g-factor, Curie temperature) have been studied for a number of polycrystalline mixed garnets. The merits of using these garnet compositions for microwave component applications are amplified by the fact that some of their properties may be independently controlled. ***Gordon R. Harrison and L. R. Hodges, Jr.*** *Microwave Journal*, v. 4, June 1961, p. 53-59.

ENGINEERING ECONOMICS

a • * **Cost-Capacity Factors—Equipment.** Explains how to estimate the cost of a plant or a piece of equipment of given capacity from the known cost of a plant or piece of equipment of different capacity by the "six-tenth factor" rule. ***O. T. Zimmerman and Irvin Lavine.*** *Cost Engineering*, v. 6, no. 2, Apr. 1961, p. 13-22.

b • **How Big a Plant?** Mathematical models, already shown to be useful in operations research for other areas of decision making, can be applied to profitability studies. ***Sidney W. Hees and James B. Weaver.*** *Industrial and Engineering Chemistry*, v. 53, July 1961, p. 47A-48A.

c • * **Nitrogen Market in Scandinavia.** With the exception of Finland, and to a lesser extent Denmark, nitrogen consumption in Scandinavia has shown little change over the last three years. Broadly speaking, Scandinavia can be regarded as a self-sufficient area, and one in which it is unlikely that there will be any large increase in productive capacity in the near future, after projects planned or under construction in Denmark, Finland and Norway have been completed. *Nitrogen*, no. 11, May 1961, p. 1-9.

d • **Beryllium Supply Is Assured, Producers Expand Capacity, Line up Domestic Ores.** By the end of July, production capacity of beryllium metal will be up to 60,000 lb. per month. Development of domestic ore sources eases worries over availability. *Iron Age*, v. 187, no. 26, June 29, 1961, p. 37-38.

e • **Let's Listen to Latin America.** Suggests a new kind of assistance to underdeveloped countries. Its essence is administrative skill in the management of differences—an area in which we have more experience and knowledge than we realize. Its execution resides in the transmission of these skills to Latin administrators (fellow Americans, too). ***Charles H. Savage, Jr.*** *Harvard Business Review*, v. 39, no. 4, July-Aug. 1961, p. 103-109.

f • * **World Sources of Natural Perfume Raw Materials.** Discusses current sources, and how changing world conditions have influenced them. ***Edson F. Woodward.*** *Drug and Cosmetic Industry*, v. 88, no. 6, June 1961, p. 735 + 3 pages.

g • **Soviet Marketing—Stronger Than We Think.** In assessing the ability of Russia to wage a war, cold or hot, we must understand her internal economy. ***D. Maynard Phelps.*** *Harvard Business Review*, v. 39, no. 4, July-Aug. 1961, p. 69-80.

h • * **A Quarterly Econometric Model of the United States.** This model, while minimizing computational difficulties, demonstrates fairly accurate forecasting ability and a partial explanation, via an accelerator, of post-war fluctuations in the gross national product of the United States. ***Lowell E. Galloway and Paul E. Smith.*** *American Statistical Association, Journal*, v. 56, no. 294, June 1961, p. 379-383.

i • * **Gas Utility Programs for Area Growth.** ID's second survey of area and community development programs of gas companies shows broadened concepts and stronger service to the site-seeker. *Industrial Development*, v. 130, no. 7, June 1961, p. 60.

j • **New Technologies for Emerging Economies.** The underdeveloped nations of the world cry out for help in making the transition from technological backwardness into the industrially productive twentieth century. Here is a stimulating new method by which the United States can intelligently assist these nations in reaching technological maturity. ***Jack Baranson.*** *Harvard Business Review*, v. 39, no. 4, July-Aug. 1961, p. 144 + 4 pages.

k • * **U.N. Launches Global Industrial Development Program.** Official worldwide recognition of the importance of industrial development is now a reality, with the activation of the U. N. Committee on Industrial Development. ***Philippe de Seynes.*** *Industrial Development*, v. 130, no. 7, June 1961, p. 6 + 3 pages.

* **Reds Use Trade to Split West.** Space feats hold attention as economic war grinds out gains. ***Leon M. Herman.*** *Nation's Business*, v. 49, July 1961, p. 38 + 3 pages.

* **Developments in Plant Location Theory.** Objective of these reference studies is to provide expansion-planning executives with a rudimentary knowledge of the theoretical principles accepted by the most astute students of industrial location as a science. ***V. W. Ruttan and L. T. Wallace.*** *Industrial Development*, v. 130, no. 7, June 1961, p. 57-59.

* **Arizona: A Century of Progress in a Decade.** After a slow start, the Grand Canyon State has lately been coming into her own like Cinderella. ***Frank Stedman.*** *Industrial Development*, v. 130, no. 7, June 1961, p. 42-44.

FLUID MECHANICS

* **Concerning One Characteristic of Transonic Gas Flows.** Studies the general conditions under which the transition surface from subsonic velocities to transonic velocities coincides with the characteristic surface of equations of gas dynamics. The case considered is unique when the transonic field of flow can be considered as independent of its subsonic part, since the compound problem for the system of equations in special derivatives, appearing when transonic flows are formed, is decomposed into a purely hyperbolic and a purely elliptic problem. (*In Russian.*) Ob odnom svoĭstve transzvukovykh techeniĭ gaza. ***O. S. Ryzhov and Iu. D. Shmyglevskiĭ.*** *Prikladnaia Matematika i Mekhanika*, v. 25, no. 3, 1961, p. 453-455.

* **Interaction of Magnetohydrodynamic Waves.** Studies the reciprocal action of rapid (S^+) and slow (S^-) impact waves, rapid (R^+) and slow (R^-) waves of rarefaction, as well as the interaction of magnetohydrodynamic waves with a plane ideally conducting wall, in order to determine possible wave combinations. (*In Russian.*) Vzaimodeĭstvie magnitogidrodinamicheskikh voln. ***V. V. Gogosov.*** *Prikladnaia Matematika i Mekhanika*, v. 25, no. 3, 1961, p. 456-467.

* **Some Properties of Supersonic Conic Gas Flows.** Analyzes the effects of a shock wave produced by a conical body entirely outside the Mach cone constructed for an undisturbed uniform supersonic gas flow, on the field of conical flow in highest approximations. (*In Russian.*) O nekotorykh svoĭstvakh sverkhzvukovykh konicheskikh techeniĭ gaza. ***B. M. Bulakh.*** *Prikladnaia Matematika i Mekhanika*, v. 25, no. 3, 1961, p. 478-484.

* **Theory by Approximation of the Front Wave Appearing on a Cylindrical Enclosure in a Uniform Elastic Medium.** Studies the front wave appearing during the fall of a plane elastic wave on a rigid cylinder. The processes in this case (corresponding to the Kirchhoff principle) are considered only in the illuminated area. Kinematically the front wave cannot occur in the dark area. (*In Russian.*) Priblizhennaia teoriia golovnoĭ volny, voznikaiushcheĭ na tsilindricheskom vkliuchenii v odnorodnoĭ uprugoĭ srede. ***G. A. Skuridin.*** *Prikladnaia Matematika i Mekhanika*, v. 25, no. 3, 1961, p. 490-497.

Flow of Non-Newtonian Fluids in a Magnetic Field. The analytical solution to the equation of motion is given for the steady laminar flow of a uniformly conducting incompressible non-Newtonian fluid between two parallel planes. The fluid is under the influence of a constant pressure gradient and is subjected to a steady magnetic field perpendicular to the direction of motion. ***Turgut Sarpkaya.*** *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 324-328.

Turbulent Flow—A Historical Review. A summary of the articles on turbulent flow in the technical literature, including experimental data and mathematical models. ***Richard LeBaron Bowen, Jr.*** *Chemical Engineering*, v. 68, July 10, 1961, p. 147 + 2 pages.

* **An Application of the Thermosiphon Circulation to the Study of the Flow of a Vapor in a Porous Medium.** The study of the flow of a condensable gas through a porous wall as a rule requires the use of circulation pumps which involve many difficulties as to the stability of the system and as to the problem of corrosion. Natural convection combined with the use of highly sensitive thermal flowmeter eliminate these difficulties. (*In French.*) Application de la circulation par thermosiphon à l'étude de l'écoulement d'une vapeur dans un milieu poreux. ***Jean-Claude Sapet, Charles Daneyrolle, and Daniel Massignon.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, v. 252, no. 22, May 29, 1961, p. 3389-3391.

* **Effects of the Shape of the Pores on the Rate of Flow of a Vapor Through a Porous Body.** This type of flow can involve the simultaneous participation of three rates of flow: a rate of flow in gaseous phase, in adsorbed phase, and under capillary condensation conditions. Only experiments allow the actual determination of their relative importance. (*In French.*) Influence de la forme des pores sur le débit d'une vapeur à travers un corps poreux. ***Paul Eyraud.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, v. 252, no. 22, May 29, 1961, p. 3386-3388.

Expansion Coefficients for Orifice Meters in Pipes Less Than One Inch in Diameter. Practical technique can be employed in pipes less than 1 in. ID, as well as in larger sizes. An analytical expression for the orifice expansion coefficient is developed; this expression includes an empirical factor based on published data for orifice installations in pipes two or more inches in diameter. Experimental verification has shown that the equation gives correct results for the smaller systems and in gases with a specific heat ratio other than 1.3 or 1.4. ***G. A. Marxman and H. Burlage, Jr.*** *ASME, Transactions, Series D, Journal of Basic Engineering*, v. 83, no. 2, June 1961, p. 289-298.

Dynamic Behavior of a Simple Pneumatic Pressure Reducer. Nonlinear and the linearized problems were studied. Stability problem was studied also, and a set of stability criteria for the linearized case was formulated in terms of the design and operating parameters of the reducer. Flow forces on three typical flowmetering valves were determined by experimental measurements. ***D. H. Tsai and E. C. Cassidy.*** *ASME, Transactions, Series D, Journal of Basic Engineering*, v. 83, no. 2, June 1961, p. 253-264.

Charts for Conical and Two-Dimensional Oblique-Shock Flow Parameters in Helium at Mach Numbers From About 1 to 100. Charts are presented for the determination of certain flow properties in the flow field and on the surface of cones and wedges at Mach numbers from about 1 to 100 in a perfect gas with a ratio of specific heats of 5/3. In addition, a table of the isentropic subsonic flow parameters is included. ***Arthur Henderson, Jr. and Dorothy O. Braswell.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN-D-819*, June 1961, 183 pp. (TL570 Un3t Room 290)

Transient Capillary Rise in Reduced and Zero-Gravity Fields. The response in a low-gravity environment is of interest in studying the behavior of liquid systems for space vehicles. ***Robert Siegel.*** *ASME, Transactions, Series E, Journal of Applied Mechanics*, v. 28, no. 2, June 1961, p. 165-170.

* **On Theorems of Minimum Energy Dissipation in Magnetohydrodynamics.** This paper is concerned with some theorems on the dissipation of energy in magnetohydrodynamics. It is shown that when certain conditions are satisfied, the steady motion of an electrically conducting incompressible fluid has an absolute minimum of energy dissipation. Furthermore, when the same conditions are satisfied, an unsteady motion with steady boundary conditions always tends to its steady state, which is stable as well as unique. The present theorems are also applicable to ordinary hydrodynamics and magnetohydrostatics. A brief implication of these theorems is discussed. ***L. N. Tao.*** *Applied Scientific Research, Sec. B, Electrophysics, Acoustics, Optics, Mathematical Methods*, v. 9, no. 2, 1961, p. 161-168.

* **On the Stability of Inviscid Parallel Flow in Hydromagnetics.** Discusses the stability of parallel flow of conducting and inviscid fluid between two fixed and concentric cylinders in the presence of an axial uniform magnetic field. It will be shown that every flow $W(r)$ is stable for infinitesimal perturbations. ***R. K. Jain.*** *Applied Scientific Research, Sec. B, Electrophysics, Acoustics, Optics, Mathematical Methods*, v. 9, no. 2, 1961, p. 85-88.

Determining End of Laminar Region. In non-Newtonian flow, the onset of turbulent flow is at different Reynolds numbers for different pipe sizes. Here is how to determine where the turbulent region begins. ***Richard LeBaron Bowen, Jr.*** *Chemical Engineering*, v. 68, June 26, 1961, p. 127-130.

A Theoretical Study of the Diffusion of Tracer Gas in an Airway. The theory of G. I. Taylor relating to diffusion in a turbulent stream is used to provide constants appropriate to the diffusion of gas in an airway. The diffusion equation is solved for steady and instantaneous gas sources of various types in airways of arbitrary cross-section, and the mixing length for a source waved about in the airway is estimated. The work relates to the measurement of air flow in airways when the use of anemometers is not possible. ***D. W. Jordan.*** *Quarterly Journal of Mechanics and Applied Mathematics,* v. 14, pt. 2, May 1961, p. 203-222.

a * **Stability of Laminar Flows.** The standard terminology is described, and the mathematical problem is outlined for a few simple laminar flows, including the boundary layer. The engineering significance of the theory and some aspects of the complete problem of transition from laminar to turbulent flow are also considered. ***D. W. Dunn.*** *Canadian Aeronautical Journal,* v. 7, no. 4, Apr. 1961, p. 153-170.

b * **A Flow Pattern at High Subsonic Speeds Past a Wedge at Incidence in a Free Stream and a Choked Channel.** ***J. B. Helliwell.*** *Journal of Mathematics and Physics,* v. 40, no. 1, Apr. 1961, p. 1-22.

c * **Characteristic Functional for Plasma Turbulence.** The functional analytical description of magnetohydrodynamic turbulence of an incompressible plasma flow is investigated by the method introduced by Hopf for the ordinary hydrodynamic turbulence. An exact stationary solution of the functional differential equation for the characteristic functional is given for the special case of inviscid and infinitely conducting plasma. This solution shows the equi-partition of the kinetic and magnetic energies. A formal general solution is also obtained by assuming the possibility of the functional Fourier transformation. ***Keniti Goto.*** *Progress of Theoretical Physics,* v. 25, no. 4, Apr. 1961, p. 603-612.

d **The Hole Theory of Liquids.** Concludes that this theory fails to provide a satisfactory description of the critical point of the liquid state. ***J. Grindlay.*** *Physical Society, Proceedings,* v. 77, pt. 5, May 1961, p. 1001-1004.

FOOD TECHNOLOGY

Vitamin Stability in Fortified Potato Flakes. In the flake process, a retention of both natural and added Vitamin C during processing is 71-73%. On storage for 28 weeks at 75 F in an air pack, flakes of 5% moisture containing antioxidant, retained 70-76% of the natural and added Vitamin C remaining after processing. In a nitrogen pack, substantially all of the Vitamin C that survived processing was retained after 28 weeks of storage. ***James Cording, Jr., Roderick K. Eskew, G. J. Salinard, and John F. Sullivan.*** *Food Technology,* v. 15, June 1961, p. 279-282.

Effect of Processing Method and Variety on Niacin and Ether Extract Content of Green and Roasted Coffee. The effect of variety and coffee cherry processing methods on the ether extract and niacin content of green and roasted coffee was studied. Methods of processing the cherry affected neither in green coffee, but did affect niacin content in roasted coffee. Alkaline treatment of the cherry generally resulted in a lower niacin content than found in the naturally fermented samples. ***Ricardo Bressani, Donald Fiester, Delia A. Navarrete, and Nevin S. Scrimshaw.*** *Food Technology,* v. 15, June 1961, p. 306-308.

* **Effect of Vitamin B_6 on the Growth of Rats Fed Diets Limiting in an Essential Amino Acid and on the Utilization of Isomers of Tryptophan, Methionine and Valine.** The growth-promoting activities of both the L- and D-isomers of the amino acids studied were enhanced with increased amounts of pyridoxine in the diets. With an optimum amount of vitamin B_6 in the diet, D-methionine and the hydroxy analogue of methionine were equal to L-methionine in promoting growth; D-tryptophan was about 50% as active as L-tryptophan; D-valine was less than one-third as effective as L-valine. ***H. E. Sauberlich.*** *Journal of Nutrition,* v. 74, no. 3, July 1961, p. 289-297.

* **Effects of Feeding a Vitamin K-Deficient Ration Containing Irradiated Beef to Rats, Dogs and Cats.** A ration containing beef irradiated with 2.79 megarads fed to 12 male, Sprague-Dawley rats caused the death of 75% of the rats because of hemorrhage. When three male cats and three male dogs, however, were fed a ration containing irradiated beef for 40 weeks, all gained weight and the prothrombin time of the blood remained normal. ***Elwood F. Reber and Om P. Malhotra.*** *Journal of Nutrition,* v. 74, no. 3, July 1961, p. 191-193.

* **All-Vegetable Protein Mixtures for Human Feeding. III. The Development of INCAP Vegetable Mixture Nine. IV. Biological Testing of INCAP Vegetable Mixture Nine in Chicks.** The experiments presented resulted in the designation of a new formula for potential human consumption. Called INCAP Vegetable Mixture 9, it contained the following percentage composition: ground yellow corn, 28; ground sorghum grain, 28; cottonseed flour, 38; Torula yeast, 3; and dehydrated leaf meal, 3. III. ***R. Bressani, L. G. Elías, A. Aguirre, and N. S. Scrimshaw;*** IV. ***R. Bressani, et al.*** *Journal of Nutrition,* v. 74, no. 3, July 1961, p. 201-216.

* **Availability of Amino Acids to Micro-Organisms. III. Development of a Method for Comparison of Hydrolysates of Foods With Synthetic Simulated Mixtures.** ***Millard J. Horn and Helen W. Warren.*** *Journal of Nutrition,* v. 74, no. 3, July 1961, p. 226-232.

Continuous Pilot Plant Process Produces . . . Precooked Dehydrated Sweetpotato Flakes. ***J. J. Spadaro and E. L. Patton.*** *Food Engineering,* v. 33, July 1961, p. 46-48.

FUELS AND COMBUSTION

* **The Effect of Nitromethane Additions on the Combustion of Drops of Various Fuels Under Spheroidal Conditions.** Applies to decrease of the ignition temperature, and to the reduction of the ignition time lag. Single drops on a hot surface under spheroidal conditions were tested. Changes in the drops during evaporation, and during combustion, were determined with a movie camera. Evaporation life of the drops was measured at different temperatures. Aviation kerosene, diesel fuel, gasoline, and methyl and ethyl alcohol, were examined. The results of the tests can be important from the practical point of view for different types of combustion engines using fuel injection. ***L. Gross-Gronomski.*** *Research Council of Israel, Bulletin,* v. 9C, nos. 1-2, Feb. 1961, p. 29-38.

* **Westfield Works Pressure Gasification Plant.** Description and operation of the pressure gasification plant at the new Westfield works of the Scottish Gas Board. The first large installation in Britain. *Engineer,* v. 211, June 23, 1961, p. 1016-1019.

* **Fuels in the Canadian Non-Ferrous Metals Industry.** The object of the above study is to provide a reasonably authoritative interpretation on the interrelation of fuels in light of the considerable changes that have taken place in the Canadian energy field during the past few years. ***J. C. Botham, J. H. Walsh, and R. M. Ennis.*** *Canadian Mining and Metallurgical Bulletin,* v. 54, no. 590, June 1961, p. 466-471.

* **Evaluation of the Microscopic Methods of Coal Research From the Point of View of Applied Technique.** A review of the modern information concerning the methods of coal petrography, such as the determination of the microlites, the heterogeneity of vitrites, the determination of the coal types in mixtures, and the determination of fusite. The microscopy of lignite is limited to the bases of quantitative methods in normal and ultraviolet light. (*In Czech.*) Zhodnocení mikroskopických metod uhelného výzkumu se zřetelem na technologickou praxi. ***M. F. Kessler.*** *Paliva,* v. 41, no. 5, May 1961, p. 170-176.

GEOLOGY, GEOPHYSICS, MINERALOGY, AND MINING ENGINEERING

A Comparison of Propane and Carbon Dioxide Solvent Flooding Processes. A laboratory investigation. Oil recoveries

of from 60 to 80% of the original oil in place were obtained by these solvent flooding processes as compared with conventional waterflood recoveries of between 35 to 50% on the same cores and linear models. ***L. W. Holm.*** *A.I.Ch.E. Journal*, v. 7, no. 2, June 1961, p. 179-184.

*** Structure, Variations and Measurements of the Earth's Ionosphere and Exosphere.** Use of high-altitude rockets for the IGY period has yielded much useful information about the *E* and *F* layers of the ionosphere. Earth satellites and space probes have revealed the inner and outer radiation belt, and also ring-currents encircling the earth at distances of many earth radii. State of knowledge, and work being conducted in this field, are surveyed. ***Colman Altman.*** *Research Council of Israel, Bulletin*, v. 90, nos. 1-2, Feb. 1961, p. 39-48.

Continent and Ocean Basin Evolution by Spreading of the Sea Floor. ***Robert S. Dietz.*** *Nature*, v. 190, June 3, 1961, p. 854-857.

Precipitation of Sub-Micron Dust in Still Air by Cloud-Size Water Droplets. The results of a preliminary investigation of this problem indicate that such precipitation occurs readily under conditions described. ***M. M. Bhadani and N. G. T. Ludlow.*** *Nature*, v. 190, June 10, 1961, p. 974-976.

Seeding Whiteouts in Greenland. The precipitation mechanism involved is the classical Bergeron-Findeisen ice-crystal process. As the process continues, the ice crystals approach fall-out size, while the amount of liquid water diminishes and snowfall results. ***James E. Jiusto and Roddy R. Rogers.*** *Research Trends*, v. 9, no. 1, Spring 1961, p. 5-7.

A Notable Growth Spiral on Synthetic Diamond. Spirals were found only among one batch of crystals (1958) made by General Electric Corp. ***S. Tolansky.*** *Nature*, v. 190, June 10, 1961, p. 992.

Study of the Optimum Equipment and Utilization of an Underground Gas Reservoir of Limited Capacity. ***R. Fort.*** *Operational Research Quarterly*, v. 12, no. 1, May 1961, p. 1-15.

*** Numerical Prediction of Hurricane Movement With the Equivalent-Barotropic Model.** Predictions of hurricane trajectories made with a 150-km grid mesh are presented. By a series of comparative tests, the results suggest that more accurate forecasts were obtained using density-weighted mean initial data than with 500-mb data. The importance of horizontal mesh size on the accuracy of the calculations is also shown. ***Gene E. Birchfield.*** *Journal of Meteorology*, v. 18, no. 3, June 1961, p. 402-409.

*** A Numerical Method for the Computation of the Radiative Flux Divergence Near the Ground.** A numerical method is given, which is particularly suited for micrometeorological use. By avoiding derivatives of the emissivity for very short path lengths, this method is relatively insensitive to uncertainties in emissivity values over that range. Permits the use of different emissivities without the need of lengthy tabulations while offering all the advantages of Brooks' method. ***J. P. Funk.*** *Journal of Meteorology*, v. 18, no. 3, June 1961, p. 388-392.

*** Ultrasonic Attenuation in Water Containing Brine Shrimp in Suspension.** A study is made to determine the frequency and concentration dependence of the ultrasonic attenuation in aqueous suspensions of hatched and unhatched brine shrimp in the frequency range 1-45 Mc. In both types of suspensions a linear relationship is found to exist between the excess attenuation and concentration at each frequency. The attenuation caused by hatched brine shrimp is found to be the same when the organisms are either living or dead. ***George J. Gruber and Robert Meister.*** *Acoustical Society of America, Journal*, v. 33, June 1961, p. 733-740.

*** Mixed Oxides of Titanium and Niobium. I. II. The Crystal Structures of the Dimorphic Forms of $Ti_2Nb_{10}O_{29}$.** ***A. D. Wadsley.*** *Acta Crystallographica*, v. 14, pt. 6, June 10, 1961, p. 660-670.

*** The Structure of the Monoclinic Form of Sodium Tetrametaphosphate Tetrahydrate.** ***Helen M. Ondik, Stanley Block, and Caroline H. MacGillavry.*** *Acta Crystallographica*, v. 14, pt. 6, June 10, 1961, p. 555-561.

*** Variations in Solar Time of Extensive Air Showers.** Extensive air showers of high electron density have been recorded at an altitude of 2283 meters. Analysis of the data in solar time for a wide range of densities shows no evidence for the large semidiurnal variations previously reported by other groups. ***B. G. Wilson, J. G. G. Dionne, and F. Terentiuk.*** *Canadian Journal of Physics*, v. 39, June 1961, p. 935-940.

*** Laboratory Tests of Shielded-Electrode Logging in Model Oil Wells.** An electrolytic-tank model was used to investigate the response of a shielded-electrode electrical logging device in thin, noninvaded resistive beds of different thickness for various bed-to-borehole-resistivity contrasts. ***C. I. Pierce, J. Pasini, III, and R. B. Lowe.*** *Producers Monthly*, v. 25, no. 6, June 1961, p. 20-24.

*** Some Problems Encountered in Underwater Sound Research.** Relates experiences at the Pacific Naval Laboratory established by the Defense Research Board in 1948 to do research in marine physics in support of the National Defense program. ***H. H. A. Davidson.*** *Engineering Journal*, v. 44, June 1961, p. 76-77.

*** Barodynamic Experiments on the Failure of Rock Around Underground Excavations.** ***Yoshio Hiramatsu and Yukitoshi Oka.*** *Kyoto University, Engineering Research Institute, Technical Reports*, no. 82, Mar. 1961, 12 pp.

*** Radar Reflectivity Profiles in Thunderstorms.** Vertical profiles of radar reflectivity have been measured in the cores of New England thunderstorms and correlated with surface weather conditions reported by an extensive network of cooperating observers. Although the reflectivity differences between hailstorms and rain-thunderstorms are slight at low altitudes, they are significant in the middle and upper portions of the storms. Tornado-producing thunderstorms reveal even more striking anomalies in high-altitude reflectivity. ***Ralph J. Donaldson, Jr.*** *Journal of Meteorology*, v. 18, no. 3, June 1961, p. 292-305.

*** A Numerical Experiment on the Development of a Tropical Cyclone.** Mathematical model constructed. Based on conservation of momentum, mass, water vapor and heat. Planetary frictional (Ekman) layer included. Surface boundary (Prandtl) layer simulated. Formulation of finite difference equations. ***Akira Kasahara.*** *Journal of Meteorology*, v. 18, no. 3, June 1961, p. 259-282.

*** Prospecting for Metallic Minerals in Mississippian Rocks of Cape Breton Island, N.S.** ***Danford G. Kelley.*** *Canadian Mining Journal*, v. 82, June 1961, p. 69-71.

*** Basic Concepts Concerning Cutoff Glass Filters Used in Radiation Measurements.** Reviews the aspects involved in filter measurements. Tables are given for correcting solar-radiation measurements made with filter specimens exhibiting different characteristics within the same glass type to standard conditions. Also presented are tabular values indicating the general effect on measurements (made with the series of Schott OG1, RG2 and RG8 filters examined here) introduced by variation of 10 mμ in the lower cutoff position. ***A. K. Angström and A. J. Drummond.*** *Journal of Meteorology*, v. 18, no. 3, June 1961, p. 360-367.

GRAPHIC ARTS

*** A Simple Inexpensive Automatic Camera for Photographing at Required Intervals.** In this camera the shutter is always kept open and the object to be photographed is illuminated at required intervals. This is achieved by using a universal fractional horse power motor and a reduction gear system. During the interval between successive exposures the exposed paper will be wound up and the unexposed paper will be kept ready and stationary by the time the light for illuminating the object is switched on. The instrument can be used continuously with little personal attention. ***R. Ramanadham and K. Nagamuneswara Rao.*** *Journal of Scientific & Industrial Research*, v. 20D, Apr. 1961, p. 135-136.

*** The Dual Mechanism of Latent-Image Formation in Photographic Emulsions.** Unsensitized silver-bromide emulsions are shown to have greater low-intensity reciprocity failure for exposures to blue light than to minus-blue light. This difference of reciprocity-failure behavior increases with grain size but decreases or vanishes on spectral sensitization of the emulsions. It is shown that it is necessary to distinguish the function of chemical sensitization at high intensities from that at low intensities of exposure. The results are interpreted on the basis of two different modes of formation of latent image. ***E. A. Sutherns and E. E. Loening.*** *Journal of Photographic Science,* v. 9, no. 3, May-June 1961, p. 157-164.

*** Nanosecond Light Sources.** The sources described are powered by small capacitors or short transmission lines. Light flashes have been obtained which have half-peak durations of 8 to 50 nanoseconds. Energies greater than one-tenth of a joule have been discharged. Factors influencing flash duration are discussed. ***G. Porter and E. R. Wooding.*** *Journal of Photographic Science,* v. 9, no. 3, May-June 1961, p. 165-171.

The Astracon Tube and Its Application to High-Speed Photography. In high-speed and ultrahigh-speed photography, cameras utilizing single-stage electronic image-converter tubes have proved to be very useful. These electronic cameras however, have the disadvantage of small light gain, so that a high brightness of the primary image is required. The use of a multistage image-intensifier tube, such as the Astracon, overcomes this difficulty. A high-speed camera of "ultimate light gain", employing two Astracon tubes, has been built. With this camera, it is possible to record single photoelectron events on photographic film. The performance of this camera is discussed as a specific application of the Astracon tube in high-speed photography at extremely low light levels. ***A. E. Anderson, G. W. Goetze, and H. Kanter.*** *Society of Motion Picture and Television Engineers, Journal,* v. 70, June 1961, p. 440-442.

*** On Necessary Measurements for the Characterization and Optimum Use of Photographic Materials for Scientific Purposes.** The definition and use of the quantities called noise-equivalent quantum efficiency and noise-equivalent quantum storage are recalled. For any condition of exposure they represent abstractions from the sinusoidal response factors (acceptance factors) and granularity spectra. More subtle abstractions are able to give realistic figures of merit for lens-emulsion combinations under prescribed constraints and conditions of use. Different requirements lead to different figures of merit, but these are found to be nearly equivalent to each other over a wide range of conditions. These concepts lead to a definite solution to the ultimate sensitivity "challenge", uncertain only insofar as the conditions laid down are defective. ***P. B. Fellgett.*** *Journal of Photographic Science,* v. 9, no. 3, May-June 1961, p. 201-206.

*** Vital Tool for Rocket-Building.** Discusses use of cameras at Canaveral for tracking and detection of component failure. Some description of camera setups and mechanisms is given. ***Carl N. Brewster.*** *Industrial Photography,* v. 10, June 1961, p. 32 + 4 pages.

VFK-ÚVOJM High-Speed Framing Camera. A double-drum, high-speed framing camera capable of photographing fast-moving mechanical and electrical machinery for quantitative analysis produces 1304 pictures, each 5 by 8 mm on a 1850-mm length of unperforated 35-mm film. The camera can record at 8000 to 42,000 frames/sec, with an aperture ratio of *f*/7, and resolves 80 lines/mm. Includes a general description of camera and discussion of its design principles. ***Jan Hampl.*** *Society of Motion Picture and Television Engineers, Journal,* v. 70, June 1961, p. 443-447.

HUMAN FACTORS

*** An Experimental Magnetic "Talking Book" Machine.** This magnetic tape reproducer operates at slow speed using endless loop casettes; it is designed with the needs of blind people in mind. ***C. W. Ross.*** *British Institution of Radio Engineers, Journal,* v. 21, May 1961, p. 415-419.

*** A Reading Machine for the Blind.** Describes work done on the problems of recognizing the alphabet letters, coding the output, and placing a hand-held pick-up probe accurately on the page. ***M. P. Beddoes, E. Belyea, and W. C. Gibson.*** *Nature,* v. 190, June 3, 1961, p. 874-875.

How Does a Man Twist in the Air? Experiments in which an Olympics medallist participated have shown how, within the limits of human anatomy, a trained man can mimic the cat which falls on its feet, although using a different technique. ***Donald McDonald.*** *New Scientist,* v. 10, June 1, 1961, p. 501-503.

*** The Human Element.** A long range view of the clerical labor market. ***Franklin C. VandenBosch.*** *Data Processing,* v. 3, June 1961, p. 16-18.

*** Scientific Personnel Selection.** Key to efficient data processing operations. ***Raymond Dreyfack.*** *Data Processing,* v. 3, June 1961, 39-41.

INFORMATION RESEARCH

Utilizing Russian Technical Information. Attempts to prepare a group of research supervisors to follow Russian contributions to their areas with a minimum knowledge of the language. They are familiarized with the journals in which major contributors publish, and in general trends of their research. They are taught: the mechanics of reading Russian; to recognize scientific terms; and a bare minimum of vocabulary and inflectional forms. The intention is to equip the group to *recognize* the value of a Russian paper in their areas without actually translating it. ***J. G. Tolpin.*** *American Chemical Society, Division of Petroleum Chemistry, General Papers, Preprints,* v. 6, no. 1, Mar. 1961, p. 39-47. (TP690 Am35g Vis.)

An Annotated Bibliography on Interplanetary Dust. ***Paul W. Hodge, Frances W. Wright, and Dorrit Hoffleit.*** *Smithsonian Contributions to Astrophysics,* v. 5, no. 8, 1961, 26 pp. (QB1 Sm69.1c Contin.)

INSTRUMENTATION

*** Fresnel Diffraction Through the Edge of a Screen: Case of Slight Focusing Error in Electron Microscopy.** The Fresnel diffraction fringes on the edge of a screen by defective adjustment in electron microscopy cannot be interpreted by supposing a sharp screen edge. A correct description of the processes observed is afforded by the hypothesis of a transition zone near the edge of the screen. (*In French.*) Diffraction de Fresnel par le bord d'un écran: cas d'un faible défaut de mise au point en Microscopie électronique. ***Charles Fert and Arlette Laffitte.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 21, May 24, 1961, p. 3213-3215.

*** Study on Evaporation Method for Electron-Microscopy.** To obtain a better metallic shadow casting and a higher resolution replica, study was made of the evaporation method with regard to the relation between the shadowing quality and the distance from the evaporation source to the specimen, the effect of the form of evaporation basket and also dynamical evaporation method. As a result, it was found that the shorter the distance is, the better the shadowing quality is, if we do not consider the effect of heat radiation from the source. It was also found that good deposited film could be obtained by using a double-binding evaporation basket. Also dynamical evaporation method was attempted with materials having high evaporation temperature, and good results were obtained. ***Tadatosi Hibi and Keiji Yada.*** *Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy,* v. 13, no. 2, Apr. 1961, p. 105-115.

*** Fixing Electric Contacts to Transparent Semiconductive Layers Deposited on Glass.** Describes a method to fix electric contacts which enable glass containers to be heated with the

help of the oxide-semiconductor layer deposited. (*In Czech.*) Připevnění elektrických kontaktů na průhledné polovodivé vrstvy nanesené na skle. ***Milan Buchta.*** *Chemické Listy*, v. 55, no. 5, May 1961, p. 542-546.

• **Lip Seal Failures—Cause and Prevention.** Establishes that seals leaked because of tolerance excesses in the following lip variables: diameter, pressure, eccentricity, and material quality. ***Robert L. Dega.*** *Design News*, v. 16, June 5, 1961, p. 8-9.

Spark Chamber Symposium. The Symposium on Spark Chambers, whose proceedings are reported here, was held on Feb. 7, 1961, at the Argonne National Laboratory, Argonne, Ill. The following papers were presented: Development of the Spark Chamber: A Review; Observations on Pulsed Spark Chambers; and A 14 x 14 x 7 in. Thin Plate Spark Chamber. *Review of Scientific Instruments*, v. 32, May 1961, p. 479-531.

Smear Camera Technique for Free-Surface Velocity Measurement. Describes an optical technique which permits recording the position of a very small region of a surface as a function of time. The surface must reflect light specularly, the arrangement must allow some space in front of the surface, and the radius of curvature of the surface must be large compared with the distance over which the position is of interest. ***W. C. Davis and B. G. Craig.*** *Review of Scientific Instruments*, v. 32, May 1961, p. 579-581.

Liquid Pumping Apparatus for Use in Studying Fast Chemical Reactions. The above is capable of rapidly pumping small quantities of two dissimilar liquids at volume ratios varying from one to one to about three to one. For the conditions described herein, pumping times of the order of milliseconds were obtained for delivery volumes varying between 1 and 3 ml of liquid per pump. ***H. G. Weiss and C. W. Urmy, Jr.*** *Review of Scientific Instruments*, v. 32, May 1961, p. 586-588.

Single Pulse Method for Measurement of Electrical Double Layer Parameters. An electric analog of an electrochemical cell is assumed to consist of a constant ohmic resistance, representing the bulk electrolyte, and a parallel combination of resistance and differential capacity, representing one interface. ***J. S. Riney, G. M. Schmid, and Norman Hackerman.*** *Review of Scientific Instruments*, v. 32, May 1961, p. 588-592.

Oxygen Gauge. A high-temperature galvanic cell which measures oxygen partial pressure is described. Quantitative measurements in the region 1 to 10^{-5} atm show a nearly linear relationship between the cell emf and the logarithm of the oxygen pressure at temperatures between 600 and 750 C. ***J. Weissbart and R. Ruka.*** *Review of Scientific Instruments*, v. 32, May 1961, p. 593-595.

Stabilization of Thermometers of Borosilicate Glass for Use at High Temperatures. Studies the best heat-treatment to be given to thermometers of borosilicate glass before graduation, in order to secure good stability in use at temperatures between 400 and 500 C. Zero rises of less than 0.1 C per 100 h at 460 C were achieved by a stabilization treatment consisting of cooling from 570 to 410 C in not less than 400 h. No shorter treatment gave as good a result if the thermometers were used above 410 C. A comparison is made of the performances of three glasses, of German, American, and English origin. ***J. A. Hall and Vera M. Leaver.*** *Journal of Scientific Instruments*, v. 38, May 1961, p. 178-185.

Temperature Scanning and Logging Equipment. A description is given of an equipment designed for automatic scanning and logging of the outputs of 900 thermocouples installed in the reactor core of a nuclear generating station. ***A. C. Blay, F. C. Flint, and P. G. Davy.*** *Society of Instrument Technology, Transactions*, v. 13, no. 2, June 1961, p. 123-132.

• **The Calculations of Vacuum Technique.** A survey, useful for engineers and technicians engaged in the vacuum technique, of the recent methods and necessary numerical data for the practical calculation of the three main pumping stages occurring as a rule during the creation of a vacuum: the evacuation of the gases confined in the enclosure, the evacuation of the gases contained in the walls of the enclosure, and the evacuation of a permanent supply of gas due to leaks or to constant degasing. (*In French.*) Les calculs de la technique du vide. ***J. Delafosse and G. Mongodin.*** *Vide*, v. 16, no. 92, Mar.-Apr. 1961, p. 1-107.

a • **Assessment of the Accuracy of "Flying-Spot" Scanning for the Measurement of Microscopic Particles.** ***C. G. L. Furmidge.*** *British Journal of Applied Physics*, v. 12, June 1961, p. 268-274.

b • **Satellite Sounder and Telemeter Chart Ionosphere Electron Density.** Describes measurement and telemetry problems unique to this satellite-borne ionosounder and goes into the details of the h-f transmitter's power amplifier. ***Samuel Horowitz and Leonard Humphrey.*** *Electronics*, v. 34, no. 25, June 23, 1961, p. 50-53.

c • **Light-Weight Refractometer.** Because it is capable of detecting refractivity fluctuations that are as small as one part per million, this refractometer is useful in studying the irregularities in the refractive index of the troposphere that are important in short radio-wave transmission. It is self-contained, and weighs only 7 pounds, so it may be used in controlled or in free ascent through the atmosphere. The device is essentially a high frequency oscillator whose frequency is governed by the capacitance of an air sensing condenser. Special provision is made for reliable operation over the wide range of temperatures normally found in the troposphere. ***D. R. Hay, H. C. Martin, and H. E. Turner.*** *Review of Scientific Instruments*, v. 32, June 1961, p. 693-697.

d • **Variable Coupling Reflection Cavity for Microwave Spectroscopy.** The variable coupling scheme achieves slightly greater sensitivity than does the usual microwave bridge circuit. It can single out either the absorption or dispersion component of a resonance signal without using bridge techniques. It is considerably less sensitive to microphonic noise than is the bridge. It is recommended for use in reflection-type cavity spectrometers. ***J. P. Gordon.*** *Review of Scientific Instruments*, v. 32, June 1961, p. 658-661.

e

f LUBRICATION AND FRICTION

• **Silicones in Lubrication.** Some unusual physical properties are produced, due to the molecular structure of silicones, making them particularly valuable as high-temperature lubricants. ***D. R. Johnson and M. R. Porter.*** *British Power Engineering*, v. 3, no. 1, June 1961, p. 46-50.

g • **Hydrodynamic Lubrication of a Roller Bearing—Introduction of Parameters to Obtain Charts for Calculation.** Relative and dimensionless magnitudes are introduced. They help to establish charts which represent isothermal results for different bearing design and various running conditions. ***F. W. v. Hackewitz.*** *ASME, Transactions, Series E, Journal of Applied Mechanics*, v. 28, no. 2, June 1961, p. 297-299.

h • **A Bifurcation Phenomenon of Static Friction.** Below extreme pressures, statistically there are two branches of the coefficient of friction versus normal load relationship. The nature of one of the branches is explicable exclusively in terms of the weld-junction or adhesion theory of friction. The nature of the other, however, is not so explicable. This points to the existence of what is called the Y-term of friction, the nature of which has yet to be satisfactorily explained. ***F. F. Ling and R. S. Weiner.*** *ASME, Transactions, Series E, Journal of Applied Mechanics*, v. 28, no. 2, June 1961, p. 213-217.

i •

Lubrication at High Temperatures With Vapor-Deposited Surface Coatings. Investigates friction of metals which have been coated with inorganic films by reaction with their surrounding atmosphere. A simple indentation test capable of selecting lubricants under loads up to 12 tons is described. This shows that a film formed by heating stainless steel in CCl_2F_2 will lubricate at 400 C when the steel is deformed by over 50%. ***D. J. Baldwin and G. W. Rowe.*** *ASME, Transactions, Series D, Journal of Basic Engineering*, v. 83, no. 2, June 1961, p. 133-138.

j •

k **Perturbation Solutions for Gas-Lubricating Films.** Perturbation solutions for large and small bearing numbers are developed and applied to steady, self-acting, infinitely long, journal and plane wedge films. Bearing films of this type de-

velop load capacity as a consequence of relative surface motion. The solutions have validity for all ranges of geometrical parameters. ***W. A. Gross and E. C. Zachmanoglou.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 139-144.

Grease Lubrication Studies With Plain Journal Bearings. Grease-lubricated plain bearings will operate with relatively low coefficients of friction and low lubricant consumption as shown by an experimental investigation on 3½-in.-diam bearings. Formation of a "rheodynamic" load-carrying film; evidence of thixotropic behavior; and effects of variation of load, speed, clearance, feed rate, and lubricant properties are demonstrated. ***L. J. Bradford, E. M. Barber, and J. R. Muenger.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 153-161.

Performance of Elastic, Centrally Pivoted, Sector, Thrust-Bearing Pads. I. Describes a method of analysis that was worked out for these bearings, which includes viscosity variations in the fluid film and an approximate calculation of the pad deflections caused by the hydrodynamic pressures. Equilibrium of moments is satisfied, laminar and adiabatic conditions are assumed, and the lubricant is incompressible. ***B. Sternlicht, J. C. Reid, Jr., and E. B. Arwas.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 169-178.

The Effect of the Method of Compensation on Hydrostatic Bearing Stiffness. Capillary, orifice, and flow control valve compensation of hydrostatic thrust bearings are investigated theoretically with regard to the effect of these three methods of compensation on the stiffness of the lubricant film. Equations are derived which permit rapid determination of bearing stiffness at any given load and film thickness. ***Stanley B. Malanoski and Alfred M. Loeb.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 179-187.

Adiabatic Analysis of Elastic, Centrally Pivoted, Sector, Thrust-Bearing Pads. Emphasizes the importance of temperature in thrust-bearing analysis. The analysis presented consists of simultaneous solution of the momentum, energy, and elasticity equations for centrally pivoted, sector-shaped, thrust-bearing pads. ***B. Sternlicht, G. K. Carter, and E. B. Arwas.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 179-187.

An Assessment of the Value of Theory in Predicting Gas-Bearing Performance. The object of the paper is to indicate the value of theoretical investigations of hydrodynamic finite bearings under steady-state conditions. Methods of solution of Reynold's equation by both desk and digital computing, and methods of stabilizing the processes of solution, are described. The nondimensional data available from the solutions are stated. The outcome of an attempted solution of the energy equation is discussed. A comparison between some theoretical and experimental results is shown. ***S. Cooper.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 195-200.

Inertia Effects in Hydrostatic Thrust Bearings. Includes the predominant inertia terms in an analysis of hydrostatic thrust bearings. The influence of centripetal accelerations on the distribution of pressure is found to be considerable. For parallel surface bearings of constant film thickness the inertia effects are found to be detrimental to load capacity. In a stepped bearing, however, correct location of the step can result in an increased load capacity at speed. A consequence of the inclusion of inertia terms in the analysis is the existence of a velocity component in the axial direction. ***D. Dowson.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 227-234.

The Elasto-Hydrodynamic Lubrication of Rollers. Calculations yield the oil film thickness, the pressure distribution, and the shape of the deformed system. Solutions are given, showing the effect of load and speed; the influence of the pressure coefficient of viscosity of the oil, and of the elasticity of the rollers is also shown. The main feature of the results is the prediction of peaks of pressure on the outlet side of the system, the height of the peaks depending greatly upon the foregoing variables. ***G. D. Archard, F. C. Gair, and W. Hirst.*** *Royal Society, Proceedings,* v. 262, ser. A, June 13, 1961, p. 51-72.

* **Effect of Oil on the Pitting of Rollers.** The apparatus used in this investigation was an opposed double roller machine with rollers 70 mm diameter loaded against a 30 mm 3% nickel steel shaft rotated at 3000 rev/min. The viscosities of the test oils which were of two types, naphthenic and paraffinic, were between 3 and 530 centistokes. The equation for the viscous pressure loss in a crack, due to the compressibility of the oil, is derived. ***J. B. Martin and A. Cameron.*** *Journal of Mechanical Engineering Science,* v. 3, no. 2, June 1961, p. 148-152.

MECHANICAL ENGINEERING

On Normal Vibrations of a General Class of Nonlinear Dual-Mode Systems. A surprising feature of these systems is that they may have a greater number of normal modes than they have degrees of freedom. ***R. M. Rosenberg.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 275-283.

On the Probability Densities of the Output of Some Random Systems. The probability density, mean, and variance of the displacement of simple linear one-degree-of-freedom systems are investigated when the spring constants and the initial conditions are random variables. ***Frank Kozin.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 161-164.

Transfer-Function Derivation and Verification for a Toric Variable-Speed Drive. Basic toric relationships are utilized to derive seven linear differential equations that describe a commercial model of a toric transmission. Experimental verification of these equations is made to support the theoretical work. By means of a numerical evaluation of the transfer functions, a simplified interpretation is made to show the relationship between transmission parameters and dynamic performance. ***J. L. Harned, P. Sudhindranath, K. M. Miller, and R. J. Roddy.*** *ASME, Transactions, Series D, Journal of Basic Engineering,* v. 83, no. 2, June 1961, p. 265-274.

* **Vibrating Systems With Equal Natural Frequencies.** Deals with the free vibration of a system with *n* degrees of freedom. It is shown that such a system always has *n* mutually orthogonal principal modes, whether the natural frequencies are all different or not. A method is described by means of which the modes and frequencies can be obtained one by one. ***G. M. L. Gladwell.*** *Journal of Mechanical Engineering Science,* v. 3, no. 2, June 1961, p. 174-181.

* **Performance of Some Modern Gasket Materials.** The range of modern gasket materials available provides ample scope for choice of compressibility, sealing pressure, physical performance and chemical inertness. The basic factors governing the performance and selection of resilient seal materials and the properties of some typical modern compositions are given. *Mechanical World and Engineering Record,* v. 141, June 1961, p. 208-210.

METALLURGY

Physical Metallurgy of Nickel-Base Superalloys. Discusses strengthening mechanisms, heat treatment, and evolutionary history. Solid-solutions hardening, precipitation hardening, strengthening by B and Zr additions, and failure are considered. Also outlines the progress and describes the attitude of alloy development by British, U. S., and Soviet investigators during the years 1946-1960. Chemical compositions and mechanical properties are tabulated for 30 selected British, U. S., and Soviet alloys. ***C. H. Lund.*** *Battelle Memorial Institute, Defense Metals Information Center, DMIC Report* No. 153, May 5, 1961, 40 pp. (TN799.T5 B32.7t Vis.)

Significance of Inorganic Chemistry in Process Metallurgy. Considers the question, "Which comes first - inorganic chemical principles or process metallurgy?". ***Eugene Wainer.*** *Industrial and Engineering Chemistry,* v. 53, July 1961, p. 36A-41A.

Some Features of the Refractory Metals. Concludes that for engineering purposes the question of cost and availability limits the field to the four metals Nb, Ta, Mo, and W. As these metals have the b.c.c. structure, the significance of this and the factors affecting the ductile-to-brittle transition are discussed. Study of alloy behavior shows these metals to be mutually soluble but intermetallic compounds are formed with other metals. Reference is made to the excellent properties of the 35% rhenium alloys. A brief review of the oxidation properties of the four metals and their alloys suggests that protective coatings will be required where oxidizing conditions are present. ***L. Northcott.*** *Journal of the Less-Common Metals,* v. 3, no. 2, Apr. 1961, p. 125-148.

Bi-Metallic Pipe. Corrosion resistance, strength, and economy of bimetallic pipe. Reports on one of the bimetallic products – its fabrication, strength, and heat transfer. ***Dan Christopher.*** *Mechanical Engineering,* v. 83, June 1961, p. 68-71.

* **Prepare Now for Growing Magnesium Market.** There's an increasing demand for lightweight Mg castings in automobiles, trucks, tractors, portable tools, furniture, sporting goods, and industrial machines. Present emphasis is in aerospace vehicles and missiles. *Modern Castings,* v. 39, June 1961, p. 52-55.

* **Application of All-Aluminum Conductors to Transmission Lines.** Experience indicates satisfactory performance and economies for large sizes in the light loading district; sagging can be a problem. ***Clinton E. Calvert.*** *Electric Light and Power,* v. 39, no. 12, June 15, 1961, p. 63 + 3 pages.

* **A Review of Some Recent Developments in Copper Alloy Technology.** ***C. D. Campbell and A. H. Coote.*** *Australian Institute of Metals, Journal,* v. 6, no. 2, May 1961, p. 137-149.

* **Considerations Concerning the Kinetics of Metallurgical Reactions. I. Sintering, Degasing, Reduction. II. Evaporation and Puddling.** (*In German.*) Überlegungen über die Kinetik eisenhüttentechnischer Reaktionen. I. Sintern, Entgasen, Reduzieren. II. Verdampfen und Frischen. ***Ludwig von Bogdandy.*** *Archiv für das Eisenhüttenwesen,* v. 32, no. 5, May 1961, p. 275-296.

METALS—CORROSION

* **Effect of Some Inhibitors on the Corrosion Cracking of Steel 1X18N9 in 42% $MgCl_2$ Solution.** Steel 1X18N9, both welded and nonwelded, at initial stretching loads above the yield value, is protected from corrosion cracking in boiling 42% $MgCl_2$ solution acidified by HCl (0.1% by volume, s. g. 1.19) with the aid of inhibitor PB-5 in 0.2% concentrations. The addition of 1% BA-12 inhibitor + 0.04% KI to the boiling 42% $MgCl_2$ solution has a similar effect. The inhibitors PB-8 and BA-12 + KI retard the corrosion cracking process of the metal in this solution, but do not inhibit it completely. Divalent and trivalent iron salts (0.3 mole/1) cause complete loss of protective action of PB-5, but do not affect that of BA-12. The protective action of cathodic polarization and of inhibitors in the corrosion cracking of steel 1X18N9 in 42% $MgCl_2$ solution is additive. Anodic polarization lowers the protective action of inhibitors, but does not eliminate it completely. (*In Russian.*) Vliianie nekotorykh ingibitorov na korrozionnoe rastreskivanie stali 1Kh18N9 v 42% - nom rastvore $MgCl_2$. ***N. I. Podobaev, S. A. Balezin, and V. V. Romanov.*** *Zhurnal Fizicheskoĭ Khimii,* v. 35, no. 4, Apr. 1961, p. 748-753.

Stress-Corrosion Cracking Susceptibility of Zirconium in Ferric Chloride Solution. Zirconium was found susceptible to stress-corrosion cracking in $FeCl_3$ solutions when the applied tensile stress was above 19,000 psi. Cracking was observed to be intercrystalline, with crack propagation normal to the direction of stress. The magnitude of the applied stress had a definite influence on the time for cracking to occur; increasing the stress would decrease the time to fracture. Increasing the solution concentration would decrease the time to fracture. The strength of the solution appeared to affect crack nucleation rather than crack propagation. Aeration of the solution was found to significantly decrease the time required for fracture, apparently by increasing the rate of crack propagation. ***J. T. Dunham and H. Kato.*** *U. S. Bureau of Mines Report of Investigations,* 5784, 1961, 29 pp. (TN21 Un3r Room 290.)

* **Relationship Between the Tempering Treatment and the Corrosion Behavior of Hardenable Stainless Chromium Steels.** The effects of different tempering conditions in hardened stainless ferritic steels with 0.4% C and 14% Cr, 0.5% C, 15% Cr and 0.5% Mo, and 1.1% C, 18% Cr and 1% Mo, on the corrosion behavior and the change of the Vicker hardness were investigated. The passivation tendency was determined by a new method. The carbides produced during tempering were examined under the electron microscope. (*In German.*) Zusammenhang zwischen Anlassbehandlung und Korrosionsverhalten von härtbaren nichtrostenden Chromstählen. ***Anton Bäumel and Carl Carius.*** *Archiv für das Eisenhüttenwesen,* v. 32, no. 4, Apr. 1961, p. 237-249.

The Burning of Metals. A preliminary study was made of the mechanism by which metals burn with wires of Al, Fe, Mg, Mo, Ti, and Zr in $O_2 + N_2$ mixtures. The rate of propagation of the combustion zone along the wire is dependent upon the O_2 pressure in the atmosphere, suggesting that combustion is largely controlled by gaseous diffusion through the atmosphere. Some of the factors influencing the mode of burning and the reaction rates were studied, and the temperatures attained under the given experimental conditions were measured. The mode of burning is determined by the relative melting and boiling points of the metal and its oxide. ***P. L. Harrison and A. D. Yoffee.*** *Royal Society, Proceedings,* v. 261, ser. A, May 16, 1961, p. 357-370 + 2 plates.

Electrode Potential and Corrosion Behavior of Some Borides of Molybdenum and Zirconium. The corrosion of the compound MoB in a 0.1N KCl solution was slight, but increased with time and was determined by the weight loss and formation of boric acid in solution; as compared with the corrosion of the molybdenum boride, that of the borides of Zr is of a very low order of magnitude. It appears entirely justified to consider the interstitial compounds of Mo or Zr with B as intermetallic compounds. ***W. Beck.*** *Planseeberichte für Pulvermetallurgie,* v. 9, nos. 1-2, Apr. 1961, p. 96-108.

Corrosion of Superalloys at High Temperatures in the Presence of Contaminating Salts. The corrosion of Inconel X, Inconel 702, René 41, M-252, and WF-11 (Haynes 25) by potassium chloride and lithium fluoride at 1600 to 1900 F was studied. Thin coatings of the salts (1.5 mg/cm²) caused severe corrosion of the alloys in air, which resulted in accelerated failures of thin sheet specimens in creep-rupture testing. Rankings for the alloys based on creep-rupture tests were similar for uncoated and salt-coated materials: WF-11, René 41, and M-252 best, Inconel 702 poorer, and Inconel X poorest. The corrosion products consist mainly of oxides and spinels, and also contain small amounts of chromates. Only very little corrosion, if any, occurs without O. The presence of the salt prevents the normal formation of a protective oxide film. ***A. Moskowitz and L. Redmerski.*** *Corrosion,* v. 17, June 1961, p. 131-138.

Unity of Anaerobic and Aerobic Iron Corrosion Process in the Soil. Covers such topics as corrosion from an electrochemical point of view, the anaerobic iron corrosion process, iron corrosion by the sulfate reduction process, iron corrosion by carbonic acid reduction process, iron corrosion by nitrate reduction process, iron corrosion due to chemical substances in the soil and the aerobic iron corrosion process. A statement is made to the effect that the hydrogen acceptor, which is invariably present with all forms of iron corrosion considered, constitutes the unity in the anaerobic and aerobic iron-corrosion process in the soil. ***C. A. H. von Wolzogen Kuhr.*** *Corrosion,* v. 17, June 1961, p. 119-125.

Acid Corrosion Inhibition With Secondary Acetylenic Alcohols. Secondary acetylenic alcohols (e.g., hexynol, and ethyl octynol) function as corrosion inhibitors specifically in aqueous mineral acids. Extensive laboratory data are presented on the prevention of metallic corrosion in aqueous mineral acids with secondary acetylenic alcohols. ***John G. Funkhouser.*** *Corrosion,* v. 17, June 1961, p. 109-113.

Effect of Sunlight on the Corrosion of Steel. Laboratory tests were made which showed that the corrosion rate of steel is greater under a blue filter than under a red filter in the pres-

ence of sunlight, provided that a thin film of water covers the metal surfaces. Outdoor tests of four-months duration verified the laboratory results. Steel specimens were exposed under molded glass filters which transmitted radiation within specific spectral regions. The results indicate that ultraviolet light activates the metal surface so that corrosion is initiated sooner or progresses at a faster rate than it would in its absence. Infrared light affects the metal surface so that subsequent exposure to ultraviolet light does not produce the same increase in corrosion. ***Leonard C. Rowe.*** *Corrosion*, v. 17, June 1961, p. 93-94.

* **Electrochemical Principles of the Corrosion and Protection of Metals.** The types of anode and cathode reactions commonly found in corrosion by aqueous media are described, and the combination of these reactions in corroding, and in passivated systems, is discussed. The principal ways in which corrosion rates are increased or decreased are classified and discussed, as follows: anodic attack and cathodic protection; anodic passivation or protection and cathodic activation; anodic inhibition and stimulation; cathodic inhibition and stimulation; resistance inhibition. The importance of the use of electrochemical and other theoretical principles in the practice of corrosion and protection is emphasised. ***T. P. Hoar.*** *Journal of Applied Chemistry*, v. 11, Apr. 1961, p. 121-130.

* **Corrosion Resistance of Aluminium in Contact With Other Metals.** Guided by practical experiments recorded in the literature using new electrochemical measurements, a thorough investigation was made of the corrosion resistance of Al and its alloys in contact with other metals under the influence of corrosive media of great practical importance (water and normal atmospheres, sea water and marine atmospheres). Accordingly, contact with Zn or Cd can be recommended in water and normal atmospheres, while contact with a number of other metals is possible in certain circumstances. In sea water and marine atmospheres, Al can be used safely in contact with Zn or Cd, but in all other cases absence of insulating media would lead to marked corrosion. (*In German.*) Korrosionsbeständigkeit von Aluminium im Kontakt mit anderen Metallen. ***H. Zeiger.*** *Aluminium (Dusseldorf)*, v. 37, May 1961, p. 284-288.

* **Intercrystalline Corrosion of Aluminium and Its Prevention.** The investigation (boiling under pressure) covered the effects of the following: purity, behavior at boiling temperature, deformation temperature, steam, pH-value, salt content of the aqueous solution, inhibitors, surface protection treatment, electrolytic protection, alloy condition, and structure. The earlier explanations given by some investigators regarding the increased susceptibility of high-purity aluminum to attack by water at elevated temperatures were not applicable, or were only partly applicable, to the phenomena observed during these investigations. The establishment of how far the ordinary and high-purity aluminums are suitable for application in atomic technology and in the chemical industry, as well as suitable means for the avoidance of intercrystalline breakdown under the influence of high temperature liquids, are permitted. (*In German.*) Interkristalline Korrosion von Aluminiumwerkstoffen und ihre Verhinderung. ***E. Nachtigall.*** *Aluminium (Dusseldorf)*, v. 37, May 1961, p. 274-283.

METALS—EXTRACTION AND REFINING

* **Smelting Ferrosilicon in a Closed Type Electrical Furnace.** The use of an electrical furnace for smelting of 20% ferrosilicon resulted in a substantial economy of materials and electric energy together with a considerable output of a valuable exhaust gas. (*In Russian.*) Vyplavka ferrosilitsiia v zakrytoi elektropechi. ***G. Sh. Mikeladze, et al.*** *Stal'*, v. 21, no. 5, May 1961, p. 419-422.

* **Teeming of High-Alloy Steel.** New method of teeming under molten synthetic slag eliminates or sharply reduces the formation of folds and blisters in ingots, and increases the output. (*In Russian.*) Razlivka vysokolegirovannykh stalei. ***V. P. Osipov, et al.*** *Stal'*, v. 21, no. 5, May 1961, p. 415-418.

* **Production of Low Alloyed Bessemer Rail Steel.** Technology for the production of comparatively inexpensive Bessemer steel will lead to rails of increased durability with a minimum

expenditure of ferroalloys. (*In Russian.*) Proizvodstvo nizkolegurovannoi Bessemerovskoi rel'sovoi stali. ***M. A. Gershgorn, D. S. Kazarnovskii, I. G. Filonov, A. D. Kutsenko, and D. P. Ul'ianov.*** *Stal*, v. 21, no. 5, May 1961, p. 404-408.

* **Improvement of Auxiliary Equipment of Blast-Furnace Plants.** In the course of mastering new blast furnace auxiliary equipment, a number of design drawbacks were eliminated: first of all, the ropeless rotary car dumper, pig casting machine, and equipment for granulation of slag. (*In Russian.*) Usovershenstvovanie vspomogatel'nogo oborudovaniia domennogo tsekha. ***I. I. Korobov, V. I. Surovov, K. I. Kotov, and A. G. Efimenko.*** *Stal'*, v. 21, no. 5, May 1961, p. 397-402.

* **Physicochemical Properties of Titanium-Magnesia Slags Containing High Alumina.** Study of properties of titanium-magnesia slags with a high alumina content allows determination of conditions for the normal operation of blast furnaces using the sinter of highly enriched titanium-magnetite ores. (*In Russian.*) Fiziko-khimicheskie svoistva titanisto-magnezial'nykh shlakov s vysokim sederzhaniem glinozema. ***V. Ia. Miller and N. M. Babushkin.*** *Stal'*, v. 21, no. 5, May 1961, p. 391-397.

* **Influence of Magnesia on Desulphurizing Power of Blast-Furnace Slags.** Experimental work showed that, under prevailing conditions, when the furnaces operated using slags containing from 8 to 12% MgO, the desulfurizing power of magnesia was 1.10-1.50 that of CaO. (*In Russian.*) Vliianie magnezii na obessepivaiushchyiu sposobnost domennykh shlakov. ***V. M. Zudin, N. N. Barbarykin, A. L. Galatonov and I. S. Kulikov.*** *Stal'*, v. 21, no. 5, May 1961, p. 385-391.

* **Hopewell Village.** Gives a detailed history of a furnace located in Berks County, Penna., that is now a national historic site. ***C. H. Vivian.*** *Compressed Air Magazine*, v. 66, June 1961, p. 18-23.

Collecting Unburnt Gases From Oxygen Converters. Advantages of lower cost dust collecting units and the recovery of useful gas decided in favor of the installation of an industrial unit at the new Dunkirk steel plant. ***M. Allard, P. Vayssiere, and G. Namy.*** *Journal of Metals*, v. 13, June 1961, p. 421-424.

A New Approach to Ladle Degassing—Bottom Bubbling. Above technique was developed to increase degassing efficiency. ***J. Duflot, J. Verge, and E. Spire.*** *Journal of Metals*, v. 13, June 1961, p. 417-418.

METALS—FINISHING, POLISHING AND CLEANING

Efficient Degreasing Essential for Quality Finishing. Different methods of cleaning are discussed. ***W. B. Hanley.*** *Industrial Finishing (London)*, v. 13, June 1961, p. 46-47.

Abrasive Belts Speed Finishing. Structure and composition of the belts are discussed in relation to various finishing processes. Some useful advice on how to obtain the best results with abrasive belt grinding and polishing, and how to obtain optimum results with the equipment selected. ***John H. Miller.*** *Industrial Finishing (London)*, v. 13, June 1961, p. 27 + 2 pages.

* **Molten Caustic De-Sands Castings.** Removal of sand from diesel cylinder head castings by leaching the sand grains out by immersion in molten NaOH at 950 F. *American Machinist*, v. 105, June 26, 1961, p. 78.

METALS—FOUNDRY PRACTICE

* **Rapid Desulfurization to 0.002 Per Cent Sulfur.** The development of a simple desulfurization procedure that rapidly and consistently reduces S from initial values as high as 0.024% to final residuals of 0.002/0.003%. ***Edward J. Dunn, Jr.*** *Modern Castings*, v. 39, June 1961, p. 90-94.

* **Initial Bubble Test for Determination of Hydrogen Content in Molten Aluminum.** Involves maintaining a small sample of an aluminum alloy in the molten state while the pressure over the sample is slowly reduced. At some pressure less than one atmosphere, bubbles of gas will nucleate and break through the surface. This pressure and specimen temperature was related to the actual specimen H content as determined by the vacuum subfusion method, over a wide range of gas content. ***D. J. Neil and A. C. Burr.*** *Modern Castings*, v. 39, June 1961, p. 86-89.

* **Jolt Impact Test for Molding Sand Toughness.** The relationship between various molding sand properties and jolt toughness of sand are shown which can be used to start a control program on sand toughness. This will lead to better rammed molds. ***H. W. Dietert and T. E. Barlow.*** *Modern Castings*, v. 39, June 1961, p. 80-85.

* **Cast Metals and Cast Shapes.** Evidence is presented that slight changes in shape and size by design can significantly increase load carrying ability by decreasing applied stress. The possible decrease in applied stress by design overshadows variations in strength of metals to such a degree as to make the classic mechanical properties of the metal of minor significance. ***J. B. Caine.*** *Modern Castings*, v. 39, June 1961, p. 73-79.

* **Solidification of Gray Iron.** A study on the influence of inoculation and the eutectic cell size was conducted in an attempt to determine the reasons for the variation in mold wall movement behavior resulting from inoculation. ***H. D. Merchant and J. F. Wallace.*** *Modern Castings*, v. 39, June 1961, p. 63-72.

* **Vacuum Die Castings—A New Evaluation.** Offers advantages if the die caster must meet requirements beyond the scope of regular methods. *Modern Castings*, v. 39, June 1961, p. 56-58.

* **Malleable Cast Iron Specially Controlled on the Mutual Relations Among Silicon, Manganese and Sulfur.** Without the restriction of the usual chemical compositions of Si, Mn and S in ordinary malleable iron a special malleable iron was manufactured, which showed a higher strength and a higher rate of malleablization. ***Masao Homma, Yoshihiko Abe, Hiroshi Meguro, and Akira Minato.*** *Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy*, v. 13, no. 2, Apr. 1961, p. 82-90.

METALS—HEAT TREATMENT

Nitriding of Type 304 Stainless Steel in a Sodium-Nitrogen System. Type 304 stainless steel is nitrided in a 1000 F Na system covered with N gas. Observations were made using a flowing Na loop. The degree of nitriding is heaviest at the interface between the Na and N. The nitriding process strengthens Type 304 stainless steel at elevated temperatures and produces a marked decrease in its ductility. ***J. J. Gill and J. C. Bokros.*** *U. S. Atomic Energy Commission, NAA-SR-6162*, May 30, 1961 10 pp. (UF767 Un3.1na Contin.)

* **The "Boiling Layer", a New Hardening Medium With Adjustable Cooling Capacity.** Some advantages of the method described are a continuous operation independent of the cooling property with control of the cooling speed, so that the heat treatment process can be automated; the possibility of displacing the parts freely in the bath, because of the low viscosity of the boiling layer, the possibility of cooling the ingots immediately after shakeout; the sharp decrease of losses during the heat treatment. (*In Russian.*) "Kipiashchiĭ sloĭ"—novaia zakalochnaia sreda s reguliruemoĭ okhlazhdaiushcheĭ sposobnost'iu. ***N. N. Varygin.*** *Metallovedenie i Termicheskaia Obrabotka Metallov*, 1961, no. 6, June, p. 13-18.

METALS—MECHANICAL AND PHYSICAL PROPERTIES

Hot Hardness Testing Applied to the Ageing and Heat Treatment of Beryllium. Sections from extruded rod, produced from thermally reduced pebble metal ingot, and from

electrolytically reduced flake metal ingot, were tested at temperatures up to 600 C. The results show that pebble metal exhibits both strain and precipitation aging mechanisms, these being removed by precipitation annealing between 600 and 800 C with consequent improvement in high-temperature ductility characteristics. No such phenomena were detected in flake material. ***R. Thomson, B. Begley, and A. J. Martin.*** *Journal of the Less-Common Metals*, v. 3, no. 2, Apr. 1961, p. 170-178.

The Fracture Characteristics of Brass in Impact at Atmospheric and Elevated Temperatures. Pure α-brass in the cast or wrought condition did not fracture in the Hounsfield impact test at temperatures up to 800 C. Binary β-brass (including material made from spectrographically pure metals), as well as more complex alloys, in the cast condition developed a range of intercrystalline brittleness starting at approximately 200 C and ending when the structure became disordered. ***A. R. Bailey.*** *Institute of Metals, Journal*, v. 5, pt. 21, May 1961, p. 339-342.

Axial-Load and Strain-Cycling Fatigue of Copper at Low Endurance. Pure Cu, annealed and cold worked, was tested under axial conditions of constant-load cycling and constant-strain cycling to give endurances to fracture between a single pull and ~50,000 cycles. Mean loads and strains of zero and of half the maximum in tension were studied. ***P. P. Benham.*** *Institute of Metals, Journal*, v. 5, pt. 21, May 1961, p. 328-338.

Hot Hardness and Other Properties of Some Binary Intermetallic Compounds of Aluminium. Specimens were prepared, and hardness results obtained, over the range from room temperature to 600 C. The results are discussed in an attempt to arrive at a fundamental understanding of their properties, and also in relation to practical uses for alloys containing these phases. ***E. R. Petty.*** *Institute of Metals, Journal*, v. 5, pt. 21, May 1961, p. 343-349.

* **The Mechanical Properties and Structure of Some High Tensile Alloy Steels.** Some outstanding results were obtained while the mechanical and tempering properties of some Si-Mo-V-Cu high-tensile alloy steels were investigated, in the water quenched and tempered condition. Metallography was limited to optical microscopy, however, in spite of this limitation some relationship between mechanical properties and microstructure could be found. ***S. Becker and M. G. Bader.*** *Research Council of Israel, Bulletin*, v. 9C, nos. 1-2, Feb. 1961, p. 61-78.

* **Effect of Carbon on the Magnetic Properties of Transformer Steel.** When investigating the influence of carbon on specific losses of transformer steel, it is necessary to take into consideration the shape and degree of dispersion of carbon inclusions. (*In Russian.*) Vliianie ugleroda na magnitnye svoĭstva transformatornoĭ stali. ***G. N. Shubin, et al.*** *Stal'*, v. 21, no. 5, May 1961, p. 445-448.

* **Effects of Elevated Oxygen and Nitrogen Contents on the Mechanical Properties of Titanium.** Up to 0.410% O in Ti considerably increases the strength of the metal at room temperature without any decrease of plasticity. This strength is not maintained at high temperatures. Nitrogen has a higher effect than O on the strength of Ti at room temperature. The same effect is maintained at high temperatures. The effect of O and N additions on the mechanical properties of welds is similar to those in connection with the basic metal. (*In Russian.*) Vliianie povyshennykh soderzhaniĭ kisloroda i azota na mekhanicheskie svoĭstva titana. ***E. V. Petunina.*** *Metallovedenie i Termicheskaia Obrabotka Metallov*, 1961 no. 6, June, p. 50-53.

* **Effects of Calcium on the Plastic Properties of Alloy EI765.** Calcium purifies the grain boundaries from the α-phase precipitating on it; this purification is equal to the distribution of this phase through the entire volume of the metal; it causes also a sharp drop of plasticity, and the appearing of a dark etching phase. When the metal is maintained in the modification furnace, Ca is burned, the α'-phase coagulates and precipitates on the grain boundaries, and the dark etching phase disappears. (*In Russian.*) Vliianie kal'tsiia na plasticheskie svoĭstva splava EI765. ***S. A. Iodkovskiĭ and A. S. Loboda.*** *Metallovedenie i Termicheskaia Obrabotka Metallov*, 1961, no. 6, June, p. 57-59.

*** Magnetic Properties of Nickel Deposits Obtained by the Nickel-Plating Method.** Tests revealed that the ferromagnetic properties of chemically deposited Ni differ sharply from the properties of pure Ni. Increasing hypophosphite in the second bath causes a decrease of the ferromagnetic properties of the deposits. A linear decrease of I_s, I_r, and H_c with increasing temperature was observed. The Curie point of the deposits is considerably below the Curie point of pure Ni, which apparently is due to the presence of P in the deposits. (*In Russian.*) O magnitnykh svoistvakh osadkov nikelia, poluchaemykh metodom khimicheskogo nikelirovaniia. ***N. V. Kotel'nikov and V. I. Gachegov.*** *Akademiia Nauk SSSR, Izvestiia, Seriia Fizicheskaia,* v. 25, no. 5, May 1961, p. 655-659.

*** Effects of the Size of the Austenitic Grain on the Plasticity of Steel 9KhF.** The coarser the grain, the lower the plasticity of this steel, and the more it tends to crack at temperatures close to the lower interval of forging temperatures (750-900 C). Resistance to deformation is highest with an average grain size of 0.4 mm, and the lowest with a 0.2-mm grain in the cast and in the forged states. (*In Russian.*) Vliianie velichiny austenitnogo zerna na plastichnost' stali 9KhF. ***G. M. Belkov and N. T. Litenko.*** *Metallovedenie i Termicheskaia Obrabotka Metallov,* 1961, no. 6, June, p. 21-24.

*** The Theory of Diffusion During the Plastic Deformation of Metals. I. Review. II. General Functional Relations. III. Possible Nature of the Phenomenon. *Yu. P. Romashkin.*** *Soviet Physics – Solid State* (Cover-to-cover translation of *Fizika Tverdogo Tela*), v. 2, June 1961, p. 2709-2731.

*** Low Endurance Fatigue of a Mild Steel and an Aluminum Alloy.** Mild steel and an Al-Zn-Mg alloy were tested axially under cycles of constant load range and constant total strain range at frequencies between 5 and 15 c/min for endurances from monotonic tension to 50,000 cycles. Mean loads or strains of zero and half the maximum in tension were studied. Hysteresis loops were recorded automatically at regular intervals throughout the life to failure. For strain cycling a linear relationship was found to exist when the logarithm of the total or plastic strain range was plotted against the logarithm of the number of cycles, for each metal and mean strain. ***P. P. Benham and Hugh Ford.*** *Journal of Mechanical Engineering Science,* v. 3, no. 2, June 1961, p. 119-132.

METALS—MECHANICAL WORKING

*** Measurement and Significance of Radial Forces in the Cutting Action of Twist Drills.** The rotary radial force is proportional to the oversize of the hole expressed in per cent. ***G. Spur.*** *Microtecnic* (English Edition), v. 15, no. 2, Apr. 1961, p. 47-59.

*** Contribution to the Question Relating to the Forces Acting on a Turning Tool.** Attempts to show that the decomposition of the forces measured under the assumption of a single force acting on the top rake face and in neglecting the force doubtlessly present also on the relief face, leads to unsatisfactory results. ***E. Bickel.*** *Microtecnic* (English Edition), v. 15, no. 2, Apr. 1961, p. 39-43.

*** Practice in Rolling a New Key-Ring Section for 8.5B-20 Type Wheel in a Continuous Mill.** Experimental rolling tests indicate practicality of manufacturing the key-ring section in a continuous mill. Calculation of calibration parameters. (*In Russian.*) Opyt osvoeniia novogo profilia zamochnogo kol'tsa kolesa 8.5B-20 na napreryvnom stane. ***P. I. Kopytin.*** *Stal',* v. 21, no. 5, May 1961, p. 425-428.

*** Practice in Rolling High-Manganese Rails.** Experience, accumulated in commercial scale rolling, proved the possibility for production of the rails with satisfactory mechanical properties and structure from high-manganese steel. (*In Russian.*) Opyt prokatki vysokomargantsovistykh rel'sov. ***P. S. Plekhanov, V. A. Koshkin, and I. A. Kritinin.*** *Stal',* v. 21, no. 5, May 1961, p. 423-425.

Collected Papers 1960. Technical papers presented at 28th Semiannual Meeting on metal cutting, numerical control, process engineering, tooling design, metalworking principles, dimensional metrology, and manufacturing planning and control. v. LX. Books 1-2. Sections individually paged. 1960. American Society of Tool and Manufacturing Engineers, Detroit. (TJ1185 Am35c Vis.)

Cold Impact Alters Grain Flow to Boost Socket Strength. Using a cold-impact process, a manufacturer holds tolerances of ±0.002 in. on a new line of superstrength sockets. *Iron Age,* v. 187, no. 25, June 22, 1961, p. 130-131.

Aluminium Alloys for Deep Drawing. Cupping tests and effect of composition and rolling slab quality on control in sheet manufacture. ***C. J. Smith.*** *Metal Industry,* v. 98, June 9, 1961, p. 451-453.

Plastic Working. Reviews the literature on forging, rolling, sheet forming, and extrusion. ***Francis W. Boulger.*** *Mechanical Engineering,* v. 83, June 1961, p. 55-57.

Metal Cutting Analysis. A state-of-the-art report on electrolytic and ultrasonic machining, spark erosion, chemical milling, plasma jets, grinding, cutting, forging, and extrusion. ***J. S. Campbell, et al.*** *Mechanical Engineering,* v. 83, June 1961, p. 49-53.

*** Turning Malleable Irons.** Two research programs have produced data on the machining of malleable irons. ***Hans J. Heine.*** *American Machinist,* v. 105, June 12, 1961, p. 117-124.

*** How to Choose the Right Carbide.** A guide that shows how variations in chemical and metallurgical properties affect carbide cutting tool performance. ***G. C. Nalon and R. G. Brierley.*** *American Machinist,* v. 105, June 12, 1961, p. 95-98.

METALS—METALLOGRAPHY, TRANSFORMATIONS, AND STRUCTURES

*** Non-Metallic Inclusions of Phosphorus in Steel.** Shows that phosphorus is present in the steel in the form of a solution in iron, phosphides, and oxygen compounds of iron and phosphorus (but not as iron triphosphate). (*In Russian.*) Nemetallicheskie v-kliucheniia fosfora v stali. ***O. D. Moldavskii.*** *Stal',* v. 21, no. 5, May 1961, p. 441-445.

The Structure of Some Electrodeposited Tin Alloy Coatings. The structures of tin-lead, tin-zinc tin-cadmium, and tin-copper electrodeposits over a wide composition range were studied metallographically and by X-ray diffraction. ***R. F. Smart, R. M. Angles, and D. A. Robins.*** *Institute of Metals, Journal,* v. 5, pt. 21, May 1961, p. 349-353.

*** Activity of Chromium in Liquid Iron-Chromium System.** The activities of chromium in the liquid iron-chromium and carbon-saturated iron-chromium systems were determined at 1630 C up to about 40 at. pct. chromium by a vaporization method using radioactive chromium. Iron-chromium system is a regular solution showing a negative deviation from the Raoult's law. The interchange energy calculated from the phase diagram is also negative, but not in good agreement with the experimental value. It is theoretically inferred that the deviation from the Raoult's law is larger in iron-chromium system than in iron-nickel system. The addition of carbon lowers activities of chromium. ***Harue Wada, Yasuji Kawai, and Tunezô Saito.*** *Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy,* v. 13, no. 2, Apr. 1961, p. 96-104.

*** Nitrogen as an Alloying Element in Steels. The Effect of Nitrogen on the Tempering of Cold-Worked Steels.** On steels containing various percentages of nitrogen, manganese, aluminum and titanium, the magnetic and electrical properties have been measured under the condition of cold working and tempering. From this investigation it has become clear that: The changes at about 100, 250, and 400-550 C begin to appear with the addition of N and become conspicuous as the N increases. The relief of cold-working stress begins to appear at the temperature of about 300 C. The change at about 100 or 250 C is due to the precipitation of N or C. The changes at about 400~550 C and 650 C are due to re-solution of N and C respectively. The effect of N is reduced as Mn increases.

Yûnoshin Imai and Tetsurô Ishizaki. Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy, v. 13, no. 2, Apr. 1961, p. 57-66.

* **Effects of Plastic Deformation in the Austenitic State on the Properties of Structural Alloyed Steels.** The thermomechanical treatment increases the plasticity and strength during elongation minus 195 C. The best values of strength and plasticity were obtained after a thermomechanical treatment at 900 C. Increasing the temperature decreases these properties. The increase in the properties after thermomechanical treatment is due to the increase of the resistance to brittleness in the boundaries of the austenitic grain. (*In Russian.*) Vliianie plasticheskoĭ deformatsii v austenitnom sostoianii na svoĭstva konstruktsionnykh legirovannykh staleĭ. ***E. N. Sokolkov, S. N. Petrova, and N. P. Chuprakova.*** *Metallovedenie i Termicheskaia Obrabotka Metallov,* 1961, no. 5, May, p. 12-14.

A Study of the Effect of Cooling Rate on the Decomposition of the γ-Phase in Uranium-Low Molybdenum Alloys. The transformations that take place when uranium-molybdenum alloys are cooled at various rates from the γ-phase field have been studied for a range of compositions by an end-quenching technique. A number of metastable phases have been observed. A tentative explanation is offered to account for the transformation sequence in each alloy. ***R. F. Hills, B. R. Butcher, and J. A. Heywood.*** *Journal of the Less-Common Metals,* v. 3, no. 2, Apr. 1961, p. 155-169.

High Temperature Allotropy and Thermal Expansion of the Rare-Earth Metals. By means of high temperature X-ray techniques, the crystal structure of La, Ce, Pr, Nd, Yb, and possibly Gd, was found to be body-centered cubic at temperatures near their respective melting points. For Yb, a hexagonal close-packed structure was also observed, which was shown to be stabilized by atmospheric impurities. Evidence for possible high-temperature crystalline transformations in Gd, Tb, Dy, Ho, and Lu was obtained by means of electrical resistance measurements; Er gave no such evidence. ***F. H. Spedding, J. J. Hanak, and A. H. Daane.*** *Journal of the Less-Common Metals,* v. 3, no. 2, Apr. 1961, p. 110-124.

The Constitution of Quaternary Aluminium-Copper-Magnesium-Silicon Alloys at 500 C. The constitution of alloys containing 0-2% Si, 0-4% Mg and 0-4.5% Cu was studied by microscopic examination of alloys that had been severely worked and then annealed at 500 C for four weeks. The phases occurring in this system are identical with those that occur in the constituent ternary systems but with, in addition, a quaternary phase. The form of the aluminium solid-solution region at 500 C was deduced from the determined sections of the isotherm. The shapes of the phase-fields in these sections correspond satisfactorily with those determined from a consideration of the geometry of the phase-regions in the quaternary isotherm. Also, equations were deduced which enable the approximate positions of certain phase boundaries in any section of the aluminum-rich corner of the system to be calculated. ***D. P. Smith.*** *Metallurgia,* v. 63, May 1961, p. 223-231.

On the Mechanism of Yielding and Flow in Iron. The activation energy, activation volume, and frequency factor have been evaluated for yielding (delay time for yielding, upper yield stress, lower yield stress, and Lüders band propagation) and flow (friction stress, flow stress, and dislocation mobility) for various irons and steels from data in the literature. ***H. Conrad.*** *U. S. Atomic Energy Commission, NAA-SR-5838,* May 30, 1961, 35 pp. (UF767 Un3.1na Contin.)

One-Dimensional Order-Disorder Model Which Approaches a Second-Order Phase Transition. The calculation of the partition function for a simple one-dimensional order-disorder model is reduced to the solution of a certain functional equation. This equation is solved rigorously, and it is shown that in the limit of indefinitely long-range interactions the model exhibits a finite discontinuity in the specific heat. ***George A. Baker, Jr.*** *Physical Review,* v. 122, 2nd ser., no. 5, June 1, 1961, p. 1477-1484.

* **Grain-Boundary Diffusion During the Creep of Copper.** ***Yu. P. Romashkin and L. M. Shestopalov.*** *Soviet Physics — Solid State* (Cover-to-cover translation of *Fizika Tverdogo Tela*), v. 2, June 1961, p. 2691-2699.

* **Precipitation Hardening of Co-Base Alloys by Means of an Intermetallic Co-Mo Phase.** Concludes that coherent or partially-coherent particles with a diameter of about 50 Å are formed during the age-hardening process. It has not been possible, however, to determine whether these particles have the Co_3Mo or Co_7Mo_6 structure in the intermediate stages of precipitation. ***B. Lux and W. Bollmann.*** *Cobalt,* no. 11, June 1961, p. 4-20.

* **Cobalt-Carbon Alloys.** Objectives were to determine the metallographic structure of cobalt-carbon alloys containing up to 3% carbon, and to examine the effect of noncarbide-forming and manganese additions on the existing phases. The mechanical properties of the alloys were also evaluated. ***Jozef Dilewijns.*** *Cobalt,* no. 11, June 1961, p. 28-35.

Transformation Kinetics of a Zirconium-Uranium-Hydrogen Alloy. Eutectoid transformation of a zirconium-uranium-hydrogen alloy with an atom ratio of 1:0.03:1. ***J. C. Bokros.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 320-326.

Electron Beam Micro-Analysis of Some Plutonium-Iron Alloys. A simple method, which involves first coating the specimen with a thin plastic film, permits the examination of plutonium in an unmodified commercially-made electron beam microanalysis instrument, without incorporationg it in a glove box. No contamination of the apparatus with radioactivity was experienced. The results obtained in this way concerning the microdistribution of elements in a series of plutonium-iron alloys are presented and discussed. ***V. D. Scott.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 284-293.

Elevated Temperature Diffusion in the Systems Nb-Pt, Nb-Se, Nb-Zn, Nb-Co, Ni-Ta, and Fe-Mo. The electron probe microanalyzer has been used to determine the composition and extent of phases occurring in bimetal diffusion couples at 1100 C. A total of eighteen phases were determined in six binary systems: Nb-Pt, Nb-Se, Nb-Zn, Nb-Co, Ni-Ta, and Fe-Mo. In all cases the phases are stoichiometric and expressible in small whole numbers. ***R. E. Seebold and L. S. Birks.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 260-266.

Diffusion of Nb With Cr, Fe, Ni, Mo, and Stainless Steel. Diffusion leads to formation of hard, brittle phases of simple stoichometric compositions such as $NbCr_2$, $NbFe_2$, NbNi, and others. Cracking often occurs in the diffusion zone, usually between the intermediate phases or near the Nb-poor side of the zone but never near the Nb-rich side. Impurities and temperature have far greater influence on Nb binary diffusion than on Nb-stainless-steel diffusion. ***L. S. Birks and R. E. Seebold.*** *Journal of Nuclear Materials,* v. 3, no. 3, Mar.-Apr. 1961, p. 249-259.

METALS—POWDER

Powder Metallurgy. Proceedings of a Conference held in New York, June 13-17, 1960, under the joint sponsorship of the Metal Powder Industries Federation and the Powder Metallurgy Committee of the Institute of Metals Division, The Metallurgical Society, American Institute of Mining, Metallurgical, and Petroleum Engineers. Papers cover mechanism of sintering, dispersion strengthening, technology and methods, and materials and applications. ***Werner Leszynski, editor.*** 847 pp. 1961. Interscience Publishers, New York. (TN695 In8p)

* **Glass—Its Role in Powder Metallurgy.** Sintering under glass can be used to produce metal-glass combinations with interesting properties, or as an alternative to vacuum sintering or vacuum hot pressing of loose powder or powder metal compacts. ***D. Yarnton and D. K. Hill.*** *Engineering Materials and Design,* v. 4, July 1961, p. 439-442.

Experimental Method of Producing Porous Tungsten for Ion Rocket Engines. The effects of particle size and sintering temperature on the permeability of tungsten ionizers were investigated. Tungsten powders of 1, 10, and 20 microns average particle size were sintered at temperatures in the range of

2250 to 2900 F. Results from density measurements, metallographic examination, and nitrogen flow tests on disks representing the various combinations of particle size and sintering temperature show that porosity varies inversely with sintering temperature for 1-micron particles but that sintering temperatures up to 2900 F had no effect on the porosity of samples produced from 10- and 20-micron particles. ***Neal T. Saunders.*** *U. S. National Aeronautics and Space Administration, Technical Note, NASA TN-D-864,* June 1961, 23 pp. (TL570 Un3t Room 290.)

Sintered Copper Powder. A study of the structure, resistivity, oxidation resistance, mechanical properties, and manufacturing processes of sintered copper powder when Al_2O_3, SiO_2, or MgO is added. With addition of Al_2O_3 powder to sintered Cu powder, the strength is 50% and the hardness 100-200% higher than those of Cu at temperatures of 20-800 C; the recrystallization temperature is shifted from 300 C to 600 to 700 C. ***Ye. M. Savitskiy and A. I. Vlasov.*** *U. S. National Aeronautics and Space Administration, Technical Translation, NASA TT-F-64,* June 1961, 8 pp. (TL570 Un3tm Room 290)

Sintering Behavior of Loose Metal Powders. In pressureless compacting the density of a sintered mass of loose powders depends considerably more on particle size, particle-size distribution, and particle activity, than for pressure-compacted powders. Examples are given for spherical and irregular shaped stainless steel powders. The powder composition which results in the greatest apparent density does not necessarily sinter to the highest sintered density. The rate of sintering depends on particle-size distribution, as well as on the activity of the particles. ***H. H. Hausner.*** *Planseeberichte für Pulvermetallurgie,* v. 9, nos. 1-2, Apr. 1961, p. 26-32.

Continuous Production of High Strength Lead Strip by Direct Powder Rolling. High strength, creep-resistant lead strip can be produced by direct rolling commercially pure lead powders. Strip produced by this technique is low in cost; i. e., approximately a few cents per pounds above the price of the raw materials. Its excellent mechanical propetries should permit its widespread use in many applications where more costly alloys of lead are now being used. ***S. Storchheim and A. Cross.*** *Planseeberichte für Pulvermetallurgie,* v. 9, nos. 1-2, Apr. 1961, p. 21-25.

NONDESTRUCTIVE TESTING AND QUALITY CONTROL

Inspecting Fuel-Slug Cladding at Hanford Automatically. ***Daniel C. Worlton,*** *Nucleonics,* v. 19, July 1961, p. 92-98.

* **Detecting Service Failures in Power Plants. I. Techniques.** Discusses causes of failure of pressure members of typical steam-power cycle. Radiographic, ultrasonic, dye penetrant, and magnetic particle inspection are discussed. ***Helmut Thielsch.*** *Combustion,* v. 32, no. 12, June 1961, p. 24-31.

Coulometric Plating Thickness Meter. Found suitable routine use in plating shop. ***R. A. White.*** *Metal Industry,* v. 98, June 9, 1961, p. 455-458.

NUCLEAR PHYSICS, NUCLEONICS, AND RADIATION

* **Approximate Wave Functions in the Calculaton of Electron Excitation Accompanying the Beta-Decay of He^6.** The probability of nonexcitation of atomic electrons in the beta-decay of He^6 has been calculated using approximate wave functions including the self-consistent field ones. The results are significantly different from those obtained with wave functions which give more accurate values of the energy. ***Włodzimierz Kołos.*** *Acta Physica Polonica,* v. 20, no. 2, 1961, p. 175-178.

Energy Levels of B^{10}: Evidence of the B^{10} γ-Ray Spectrum. A study of the γ-rays produced during the bombardment of a thick Be^9 target by 600 keV deuterons was made to investigate the possible existence of a level at 2.86 MeV in B^{10}, about

which contradictory reports have appeared in the literature. A spectrum of the γ-rays in coincidence with the 0.72 MeV B^{10} γ-ray was obtained, and is interpreted as providing evidence for a level in B^{10} at 2.86 MeV. The relative intensities of the γ-rays in an ungated spectrum, and in spectra gated by the 0.72 and 1.02 MeV B^{10} γ-rays, were found, and a decay scheme consistent with the observations is deduced. The relative intensities of the transitions in this decay scheme are consistent with the intensities of the neutron groups in a spectrum of the neutrons from this reaction. A spin value of 2 or 3 is suggested for the 2.86 MeV level. ***R. B. Galloway and R. M. Sillitto.*** *Royal Society of Edinburgh, Proceedings,* Sec. A, Mathematical and Physical Sciences, v. 65, pt. 3, 1959-1960, p. 247-262. (Q41 R80.7p Vis.)

* **Pion-Pion Interaction and Nuclear Forces.** Nuclear potentials arising from the pion-pion resonance in the state $I = J = 1$ are calculated. ***Yasunori Fujii.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 441-460.

* **Variational Calculation of the Scattering Lengths in Electron-Hydrogen Scattering.** The nonrelativistic Schrödinger equation of electron plus hydrogen-atom system is solved by the Hulthén type variational method at the limit of zero incident electron energy. ***Yasuo Hara, Takashi Ohmura, and Takahiko Yamanouchi.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 467-474.

* **On Energy Matrices for the Independent Particle Model.** A method which makes use of Fourier transforms of two-body interactions for the calculations of energy matrices in the independent particle model is proposed. The non-central interactions, as well as central ones, can be easily expanded into series of tensor products of spherical harmonics by this procedure. Furthermore, the radial integrals can be reduced to simple integrals which involve the Fourier transforms of the radial dependence of the interactions. For the harmonic oscillator wave functions, the procedure can be easily carried out and explicit formulas for the integrals are obtained. Useful tables for the calculations of the integrals for the central, tensor, and spin-orbit interactions are given. ***Hisashi Horie and Kiyoshi Sasaki.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 475-492.

* **Effective Interaction in Nuclear Many-Body Problem.** General treatment of nuclear many-body problem is given in terms of Green functions, and the correlation property of nucleus is exhibited by correlation factor. Effective interaction certifying the independent particle motion is introduced and proved to identify with Brueckner's K-matrix. And on the basis of this point, applying the method of the particle-hole pair to the system, a collective mode is derived and the effective interaction contributing to collective motion studied. ***Masaru Yasuno.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 411-426.

* **Pion Theory of Nuclear Forces and Low Energy P-Wave Phase Shifts.** It is shown that low energy behaviors of the triplet P-wave phase shifts in proton-proton scattering below 20 Mev, after being corrected for vacuum polarization effect and relativistic effects and for effect of the coupling with F-wave, confirm the existence of the repulsive central tail of the one-pion-exchange potential. ***Shoichiro Otsuki, Mituo Taketani, Ryozo Tamagaki, and Wataro Watari.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 427-435.

* **The Non-Leptonic Decays of Hyperons.** The non-leptonic decays of hyperons are investigated, based on the Sakata model and the V-A theory of weak interactions. The Λ-decay and the Σ-decay are treated in a unified way. In the latter case, a possibility of interpreting the experimental evidences is given, provided that the structure of Σ-hyperon satisfies some suitable conditions. ***Ziro Maki and Yoshio Ohnuki.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 353-360.

* **Approximate Solution of the Bethe-Salpeter Equation for Two Fermions.** The eigenfunction and the binding energy of the ground state are obtained for the bound state of two fermions, which are interacting through photons or scalar photons in the ladder approximation. ***Masaaki Kawaguchi.*** *Progress of Theoretical Physics,* v. 25, no. 2, Feb. 1961, p. 178-188.

• **Electromagnetic Structure of the Nucleon and the Composite Model for Pion.** The electromagnetic structure of the nucleon is investigated, based on the composite model for the pion. The mean square radius of charge distribution of the nucleon is calculated by the second order perturbation, and the same coupling constants are used with those in the calculation of the pion-nucleon interaction and the anomalous magnetic moment of the nucleon on this model. The results are qualitatively in agreement with experiment, and it is possible to explain all these phenomena consistently from the standpoint of the composite model. ***Chiaki Ihara.*** *Progress of Theoretical Physics*, v. 25, no. 2, Feb. 1961, p. 229-234.

• **The Scattering of Deuterons in Deuterons From the Point of View of Their Mutual Distortion.** The authors derive integro-differential equations to deal with the scattering phenomenon at low energies of a few MeV. The mutual distortion of the two deuterons at close distance turns out to have a large influence on the angular distribution. A simple and plausible assumption has been made concerning this distortion, and the results have been compared with experiment for two energies. (*In German.*) Die Streuung von Deuteronen an Deuteronen unter Berücksichtigung ihrer gegenseitigen Verzerrung. ***G. Ernst and S. Flügge.*** *Zeitschrift für Physik*, v. 162, no. 5, Apr. 1961, p. 448-467.

• **A Contribution to the Study of Electron Afteremission in Ion Crystals.** The emission of electrons from NaCl-, LiF- and Zn-crystals after excitation by electrons and α-particles was investigated. The influence of external electrical fields on the emission was studied. The results of this investigation are compatible with the model developed by Matyás according to which an electrical dipole-layer is caused by the distribution of lattice defects in the surface. (*In German.*) Zur Elektronennachemission bei Ionenkristallen. ***W. Hanle, G. Kanzler, and A. Scharmann.*** *Zeitschrift für Physik*, v. 162, no. 5, Apr. 1961, p. 483-488.

• **Reciprocal Action of Neutrons in an Absorbing Material.** The neutrons often used in testing technique are artificially produced. The interaction of these neutrons with the atoms of the substances penetrated can be elastic or nonelastic. Within different energy ranges, and for reaction partners varying in weight, there is either dispersion or formation of intermediate nuclei (absorption). Several possibilities exist for the transformation of the intermediate nucleus. As regards the dependency of the effective cross section of the neutron reaction on their energy, the 1/V region, the resonance region and the region of rapid neutrons can be distinguished as a rule. (*In German.*) Die Wechselwirkung von Neutronen im absorbierenden Material. ***E. Pohl.*** *Technik*, v. 16, May 1961, p. 379-384.

Handbook of Nuclear Safety. ***Hugh K. Clark.*** *U. S. Atomic Energy Commission, DP*-532, Jan. 1961, Sections individually paged. (UF767 Un3.1dp Contin.)

• **Certain Results of Studies of Controlled Thermonuclear Reactions, Obtained in the U.S.S.R.** Results of measurements of the lifetime of fast ions are discussed. (*In Russian.*) O nekotorykh resul'tatakh issledovanii po upravliaemym termoiadernym reaktsiam, poluchennikh v S.S.S.R. ***I. V. Kurchatov.*** *Uspekhi Fizicheskikh Nauk*, v. 73, no. 4, Apr. 1961, p. 605-610 + 2 plates.

• **Work Performed on the Thermonuclear Experimental Unit OGRE.** (*In Russian.*) Orabotakh na termoiadernoi eksperimental'noi ustanovke OGRE. ***I. N. Golovin, et al.*** *Uspekhi Fizicheskikh Nauk*, v. 73, no. 4, Apr. 1961, p. 685-700.

Statistical Theory of Nuclear Fission and Prompt Neutron Distribution. It is shown that the statistical theory of nuclear fission is consistent with the recent experimental results of prompt neutron distribution in fission, if we assume the existence of some constraint in the process of approaching equilibrium which controls the partition of excitation energy between the two fragments. ***Peter Fong.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1543-1544.

Angular Distributions of $(T(p,n)He^3$ Neutrons for 3.4- to 12.4-Mev Protons. Angular distributions of the neutrons from the $T(p,n)He^3$ reaction have been obtained for incident laboratory proton energies of 3.4, 4.3, 5.0, 6.5, 8.0, 8.8, 10.3, 11.5, and 12.4 Mev. The neutrons were detected by a plastic scintillator, and standard time-of-flight techniques were used to separate the monoenergetic neutron group from background neutrons and gamma rays. The distributions in the center-of-mass system show substantial backward peaking. Above about 8-Mev proton energy, a broad maximum appears at about 80° (c.m.) and persists through the highest energy measured. The absolute 0° cross sections and the total integrated cross sections are in excellent agreement with previous measurements. ***M. D. Goldberg, J. D. Anderson, J. P. Stoering, and C. Wong.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1510-1513.

Gamma Radiation From Low Levels of Al^{27}. The $Al^{27}(\alpha,\alpha'\gamma)$ reaction was investigated by using particle-gamma coincidence techniques and the 22-Mev alpha-particle beam from the Indiana University cyclotron. A 0.79±0.03 Mev gamma-ray transition between the 3.0- and 2.21-Mev states of Al^{27} was observed. This result, together with other data, suggests that the 3.0- and 2.21-Mev states are the $9/2^+$ and $7/5^+$ members of a $K = 5/2$ rotational band. ***R. D. Bent and W. W. Eidson.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1514-1517.

Possible Parity and Time-Reversal Experiments Using the Mössbauer Effect. In the successive transition of the beta and gamma decays, the excited and ground states of the daughter nucleus are effectively polarized, when the satellites of the Mössbauer effect are separately observed. Using this nuclear polarization, we design various experiments to detect parity nonconservation and time-reversal invariance in beta decay. These experiments involve the measurements of the coincidence counting rate of beta rays and satellites of the Mössbauer effect. The resulting improvement in accuracy will make possible, for example, the precision measurement of the asymmetry of beta-ray angular distributions. ***M. Morita.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1525-1526.

Neutron Groups From $K(\alpha,n)Sc$. Neutron groups resulting from the alpha-particle bombardment of separated isotopes of potassium have been observed. Ground-state Q values of −3.42±0.06 Mev for $K^{41}(\alpha,n)Sc^{44}$ and −7.16±0.06 Mev for $K^{39}(\alpha,n)Sc^{42}$ were obtained. A large number of excited states or groupings of states were also observed. The presence of chlorine in one of the targets permitted measurement of the $Cl^{37}(\alpha,n)K^{40}$ reaction as well. A ground-state Q value of −3.86±0.06 Mev was obtained. A tentative value of −5.89±0.06 Mev can be given for the $Cl^{35}(\alpha,n)K^{38}$ ground state. ***A. M. Smith and F. E. Steigert.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1527-1530.

Core Excitations in Nondeformed, Odd-A, Nuclei. The possibility of describing some excited states of odd-A nuclei in terms of excitations of the even-even core is investigated. No assumption is made on the nature of the core excitation, but certain relations involving electromagnetic transitions and moments are deduced. These seem to fit well some data available on Ag^{107}, Ag^{109}, Au^{197}, Hg^{199}, Tl^{203}, and Tl^{205}. More experimental data are required to test the validity of this picture in other cases. ***A. de-Shalit.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1530-1536.

$Ce^{140}(d,p)Ce^{141}$ Reaction. Eight proton groups were observed, leading to levels in Ce^{141} at excitation energies of 0, 0.65, 1.12, 1.35, 1.47, 1.77, 2.15, and 2.41 Mev. Angular distributions and relative cross sections were used to make the following assignments: 7/2- for the ground state, 3/2- for the 0.65-Mev state, 3/2- for the 1.12-Mev state; 5/2- for the 1.77-Mev state, and 1/2- for the 2.41-Mev state. ***G. B. Holm and H. J. Martin, Jr.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1537-1541.

Nuclear Models and Nuclear Fission. The hindrance to spontaneous fission by the odd nucleon in the fissioning nucleus may be explained as due to the pairing energy of the odd nucleon at the saddle-point deformation. ***Peter Fong.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1545-1546.

Beta Decay of Naturally Radioactive In^{115}. A liquid scintillator loaded with In has been used to study the fourth-forbidden beta decay of In^{115}. Specific activity measurements yield a half-life of $(6.9\pm1.5)\times10^{14}$ years. A crude beta spectrum was obtained. Linear extrapolation of the Fermi-Kurie plot gives and end-point energy of 625±70 kev. ***G. B. Beard and W. H.***

Kelly. Physical Review, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1576-1579.

* **Isotope Techniques for Nuclear Engineers.** ***J. L. Putman.*** *Chemistry & Industry*, 1961, no. 22, June 3, p. 733-737.

* **British Experience in the Technical Development of Nuclear Power Reactors.** ***John Cockcroft.*** *Chemistry & Industry*, 1961, no. 22, June 3, p. 728-732.

* **Neutron Spectrum Temperature Distribution in Heterogeneous Systems With Constant Absorption.** On the basis of generalized ideas of Kottwitz, a semiphenomenological method has been developed of thermal neutron spectrum "effective-temperature" distribution evaluation in consequent P_1 approximation for heterogeneous systems with constant absorption. It has been shown that quite satisfactory results can be obtained in the case of neutron slowing down from fission energies to thermal energies, if it is assumed an effective source of epithermal neutrons with the mean energy of Fermi cutoff E_c. The method has been illustrated with numerical results for natural uranium-graphite and enriched uranium-water systems. The results have been compared with calculations using "classical" Cohen's formulae extrapolated for heterogeneous systems. ***Zbigniew Weiss.*** *Nukleonika*, v. 6, no. 4, 1961, p. 243-260.

* **An Automatic Cascade Apparatus for Producing Highly Enriched Heavy Nitrogen Isotope.** Describes a device producing N^{15} by the exhange method in the NO-HNO system. When selecting $\sim$ 0.5 g N in 24 hours, a N^{15} 99.8% concentration was obtained. The enrichment was produced from a natural N^{15} concentration equal to 0.365%. (*In Russian.*) Avtomaticheskaia kaskadnaia ustanovka dlia polucheniia vysokokontsentrirovannogo tiazhelogo izotopa azota. ***I. G. Gverdsiteli, et al.*** *Atomnaia Energiia*, v. 10, no. 5, May 1961, p. 487-492.

Angular Distributions from Heavy-Ion-Induced Fission. It is observed that the ratio of 0 to 90 deg differential cross sections is much larger for heavy ions than for lighter projectiles. For a given heavy ion, this anisotropy is found to increase with bombarding energy and decrease with the value of Z^2/A of the compound nucleus. There is no distinct evidence for a monotonic relationship between the anisotropy and the mass of the projectile. The data are interpreted within the theoretical framework proposed by Halpern and Strutinski and by Griffin to explain fission-fragment angular distributions at moderate energies. In general, these results can be described in terms of the large angular momenta and excitation energies associated with heavy-ion reactions. It is suggested that, on the average, the number of neutrons that are evaporated before fission increases as the atomic number of the compound nucleus decreases. ***Victor E. Viola, Jr.*** *U. S. Atomic Energy Commission, UCRL*-9619, Mar. 24, 1961, 91 pp. (UF767 U3u Contin.)

* **An Attempt to Calculate the Reaction $^{14}N(d, p)^{15}N$ by the Born First Approximation.** The stripping differential cross sections are calculated for the case when the 2S level of ^{15}N is formed. Thomas' variational method is applied and the angular distribution of the emerging protons is calculated by the Born first approximation for four values of the range of the Yukawa potential. The proton-target nucleus forces are found to be at least as important as the neutron-target nucleus forces. The angular distributions as obtained for the emerging protons and the absolute values of the differential cross sections are entirely different from the experimental values. The calculations give some hint that in stripping reactions the capture process takes place only on the edge of the nucleus. ***Ryszard Kołodziejski.*** *Acta Physica Polonica*, v. 20, no. 4, 1961, p. 275-280.

* **On the Shapes of Allowed Beta Spectra.** The present paper brings a discussion of the small deviations observed in the beta spectra of ^{32}P, ^{90}Y, ^{114}In and ^{22}Na. No explanation thereof exists within the framework of the conventional theory, even assuming the usually dominating nuclear matrix element to be suppressed. Two alternative explanations of the phenomenon are discussed, both of which are tentative and of a somewhat surprising character. The one ascribes the effect to G-nonconserving interactions, whereas the other hypothesis attributes the deviations to a virtual intermediary chiral spinless boson. ***Br. Kuchowicz.*** *Acta Physica Polonica*, v. 20, no. 4, 1961, p. 341-349.

a * **Behavior of Graphite in a Nuclear Reactor.** Studies the ration effects in graphite and their influence on the construction of the graphite lining of nuclear reactor. Some effects
• can cause heavy complications in the operation of the reactor. The precautions involved are examined, as well as the physical nature of the radiation effects in graphite for a wide interval of high temperatures, and the problem of preserving graphite
b from oxidation. (*In Russian.*) Povedenie grafita v kladkakh iadernykh reaktorov. ***V. I. Klimenkov.*** *Atomnaia Energiia*, v. 10, no. 5, May 1961, p. 447-460.

• **An Application of the Reciprocity Theorem to the Acceleration of Monte Carlo Calculations.** In solving two-dimensional one-energy transport problems, it is often necessary to utilize Monte Carlo calculations in situations where this
c technique converges very slowly. In problems with regionwise constant sources where the required result is the flux at a point or an integral of the flux over a region or surface, the reciprocity theorem can be used to determine an auxiliary problem
• which yields the same information while in many cases improving the statistics appreciably. The relations required in choosing the auxiliary problem are derived. The required integrals and statistical errors are stated in terms of the results
d for the auxiliary problem. Examples are given to illustrate the application of these ideas to a flux peaking situation and to the absorption in a small region. The extension of this pro-
• cedure to energy-dependent cases is discussed briefly. ***C. W. Maynard.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 97-101.

e * **Reactivity Margin Meter in the Reactor.** Described is the principle of the device for measuring the excess of reactivity in a nuclear reactor. It consists of nonlinear potentiometers coupled mechanically with the driving system of the control
• rods. The potentiometers are designed so that their characteristics are the same as those of the control rods. The potentiometers are fed from a couple of transformer's windings. The
f indicator gives a sum of the potentiometers' outputs which is proportional to the total excess of reactivity in the reactor. (*In Russian.*) Izmeritel zapasa reaktivnosti v reaktore ***Zdislav Tselin'ski.*** Nukleonika, v. 6, no. 4, 1961, p. 261-266.

• * **Semiempirical Atomic Mass Law.** New terms are proposed for the atomic mass law which incorporate effects of nuclear deformation and shell structure including interference effects
g between unfilled neutron and proton shells. In addition, a surface-symmetry term is included. Coulomb terms are fixed by recent radii determinations in electron scattering. The standard deviation of calculated recent radii determinations
• in electron scattering. The standard deviation of calculated masses is reduced by the addition of the new terms as is the error in extrapolating from one side of the valley of beta stability to the other. The usefulness of the law for calculating
h the mass and binding energy of atoms with large neutron excess is discussed. A table giving mass excess, neutron, proton and alpha-particle binding energies, and beta decay transition
• energies is appended. ***Philip A. Seeger.*** *Nuclear Physics*, v. 25, no. 1, May 1961, p. 1-135 + 1 plate.

i * **The Angular Correlation of Prompt Neutrons and Fission Fragments in Thermal Neutron Fission of U^{235}.** A combination of a gridded ionization chamber and a gas scintillation counter system using Xenon gas was used to measure the energy of the fission fragments as well as their
• direction of motion relative to the electric field direction of the ionization chamber. A fast neutron detector was placed along the electric field direction at a distance of one meter to measure the energy of the prompt neutrons by time of
j flight technique. The distributions obtained are compared with the distributions computed on the assumption of isotropic emission of neutrons with a Maxwellian emission spectrum. It is
• shown that the laboratory anisotropy $N(0°)/N(90°)$ is an increasing function of the neutron energy in the laboratory system. The laboratory angular distributions are transformed to obtain the center-of-mass angular distributions for two groups
k of prompt neutron emission energies. Anisotropy of the form $(a + b \cos^2\theta)$ is indicated for prompt neutrons with emission energies greater than 1 MeV. Anisotropy of emission is discussed in terms of the possibility of the fragments acquiring a

large angular momentum at the instant of scission. ***R. Ramanna, et al.*** *Nuclear Physics*, v. 25, no. 1, May 1961, p. 136-151 + 1 plate.

a * **The Determination of Traces of Iridium in Samples of Rhodium by Neutron-Activation and Gamma-Ray Spectrometry.** Neutron-activation analysis has been applied to the determination of traces of iridium impurity in specimens of rhodium. The Harwell Pile BEPO has been used as neutron source. The method involved irradiation of samples and standards and their subsequent γ-spectrometric assay; no radiochemical separations were required. ***D. F. C. Morris, D. N. Slater, and R. A. Killick.*** *Talanta*, v. 8, no. 6, June 1961, p. 373-376.

Radionuclide Fractionation in Bomb Debris. The fractionation systematics for high-yield bursts at sea-water and coral surfaces are delineated. ***E. C. Freiling.*** *Science*, v. 133, June 23, 1961, p. 1991-1998.

The Single-Scattering Approximation to the Solution of the Gamma-Ray Air-Scattering Problem. The results of a calculation using the single-scattering approximation, with no exponential attenuation or buildup, has been compared to results of a Monte Carlo calculation of the dose rate and number flux in air from monoenergetic gamma-ray source. The comparison shows that the simple approximation is generally adequate for unshielded detectors. ***D. K. Trubey.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 102-116.

Slowing Down From an Energy Distributed Neutron Source. Series expansion of the Laplace transforms occuring in slowing-down theory is shown to reproduce and extend the usual approximate solutions for an energy distributed source in an infinite nonabsorbing medium. The method also leads to a differential equation for the slowing-down density in an absorbing medium, which may be solved to any required accuracy. ***A. Keane.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 117-119.

Investigation on the Inelastic Moderation of Fast Neutrons. Experiments with several neutron sources (Ra-Be, D-D, D-T) are in accordance with a nearly linear dependence $\Delta\overline{E}(i)$ as a suitable phenomenological description. The mean energies were determined by means of measurement of the neutron migration areas in a large moderating water volume surrounding spherical lead and bismuth scatterers. ***C. A. Heusch and T. Springer.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 151-158.

Inelastic Scattering of Neutrons by U^{238} Below 1 Mev. The neutron excitation cross sections for the individual energy levels of U^{238} below 1 Mev have been calculated for neutron energies up to 1 Mev with the statistical theory of Hauser and Feshbach. ***Lawrence Dresner.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 142-150.

The Effect of Temperature of Xenon Instability. The space-independent dynamics of a reactor controlled by xenon and temperature effects is investigated. The boundedness of the solutions for a reactor with a prompt, negative flux coefficient is shown. Criteria are developed for reactor stability. The effect of delayed neutrons and of the time lag between power and temperature on xenon stability is considered and shown to be generally negligible. Nonlinear effects are shown to be important for reactors with negative as well as positive temperature coefficients. ***J. Chernick, G. Lellouche, and W. Wollman.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 120-131.

Minimum Critical Mass in Variable Density and Epithermal Reactors. For thermal reactors and those described by two neutron energy groups, it is shown that the adjoint fluxes of multigroup diffusion theory can be expressed as linear combinations of the neutron fluxes even when the moderator density is a function of position. For the case of thermal reactors it is shown that minimum critical mass and constant thermal flux in the core are equivalent. ***Mathew M. Shapiro.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 159-162.

Application of Rapid Fission Gas Analyses to an Off-Gas System Test. Recently developed methods for separation and analysis of radioactive fission gases have been applied to obtain data for an off-gas system of an in-pile loop. A separate in-pile test facility was designed to provide a gas transport stream

having fission products having concentrations simulating those anticipated in the off-gas system. Characterization of the radioactivities in this facility provided necessary preoperational information and specifications for operational and analytical procedures for the off-gas system test. ***R. C. Koch, G. L. Grandy, and J. A. Roll.*** *Nuclear Science and Engineering*, v. 10, June 1961, p. 183-189.

b * **Radioisotopes at Work.** Industrial applications, gaging for measurement, and tracing in flow processes. Nontechnical descriptions of uses and methods. *Machinery Lloyd (Overseas Ed.)*, v. 33, no. 12, June 10, 1961, p. 36-41.

c * **On the Validity of the Static Approximation for the Evaluation of the Two-Nucleon Potential.** The perturbative two-pion exchange nuclear potential is computed in an approximation which does not neglect the possible large recoil of the nucleons upon emission or absorption of a virtual pion. Upon the assumption that initial and final momenta are nonrelativistic, the result is still a local potential, but one to which previous completely static approximations bear only a qualitative resemblance. The corrections are of order (μ/Mx) where μ and M are the pion and nucleon masses, respectively, and x is the nucleon separation in units of the pion Compton wavelength. ***Malcolm C. Younger and Abraham Klein.*** *Franklin Institute, Journal*, v. 271, no. 6, June 1961, p. 458-470.

d **Magnetic Automatic Power-Range Control for an Aircraft Nuclear Reactor.** Advantages presented; control system elements and computing devices are treated in detail, and the performance of a breadboard version of the control system is evaluated. ***J. A. Russell, J. L. Scharf, S. F. Hemmeway, and P. C. Sharr.*** *U. S. Atomic Energy Commission, APEX-587*, May 1961, 19 pp. (UF767 Un3.1ap Contin.)

e **Applications of Ultrasonic Energy to Pyrometallurgical and Pyrochemical Processing of Nuclear Materials.** High-temperature processing of molten metal, ceramic, and fused salt systems frequently involves steps which are rate limited and/or surface controlled. Ultrasonic developments have been extended to the high-power activation of such systems. The feasibility of nuclear fuel reprocessing applications has been studied. Ultrasonic activation of molten metal systems was found to reduce from days or weeks to 2-4 hr the time required to dissolve uranium and uranium/fissium in molten cadmium or zinc. Quantitative ultrasonic reduction of uranium oxide (U_3O_8) in the molten magnesium, cadmium, or zinc systems required less than 8 hr of treatment time; nonultrasonic, mechanically stirred controls yielded only 9-11% recoveries under the same conditions. Ultrasonic mixing accelerated three to four fold the rate of extraction of copper from mercury by dilute nitric acid, a system designed to simulate the relative behavior of uranium and magnesium at 900 C. Oxide fuel pin casings which prevent the coalescence of molten uranium were shattered and dispersed by an ultrasonic probe at 1200 C at treatment times of only 2 min. Ultrasonic activation of a molten salt system (lithium and sodium fluorides) was demonstrated. Application of these interphase accelerations to larger scale and continuous processing has been briefly described. ***C. Dana McKinney, Jr., William B. Tarpley, and Robert S. Winchester.*** *U. S. Atomic Energy Commission, NYO-2581*, Apr. 1961, 45 pp. (UF767 U3ny Contin.)

f * **Evidence for the Existence of Rotational Levels in All Even Nuclei.** A theory of rotations of even nuclei is developed which is more general than the one based on the hydrodynamical model. It is assumed that the rotational motion can be treated adiabatically and that three effective moments of inertia and the two effective quadrupole moments are independent parameters. A small centrifugal distortion of the rotor is added as a correction term. The theoretical predictions for energy levels and gamma-ray transition probabilities are compared with experimental results for nuclei with $40 \leqq A \leqq 250$ and good agreement is obtained. The trends of the effective moments of inertia and effective quadrupole moments as a function of A are given. Results indicate nucleus not a rigid rotator. ***C. A. Mallmann.*** *Nuclear Physics*, v. 24, no. 4, May 1961, p. 535-575.

g **Momentum Dependence of the Asymmetry in Muon Decay.** Positive muons from the Berkeley 184-in. synchrocyclotron were stopped in various materials and the momentum

dependence of the asymmetry of positrons from their decay measured with a magnetic spectrometer. The experiment reported here was designed to permit a thorough measurement of all three parameters ρ, δ, and ξ from stopped muons by using a magnetic spectrometer as a momentum analyzer with particular emphasis on the δ parameter. ***Hans Kruger.*** *U. S. Atomic Energy Commission, UCRL-9322,* Feb. 2, 1961, 81 pp. (UF767 U3u Contin.)

A Review of Glove Box Construction and Experimentation. A series of fires and explosions in U. S. Atomic Energy Commission facilities handling α-active materials during the last five years has resulted in reconsideration of safety problems associated with glove boxes and other equipment used to contain these materials. The literature on construction and operation of glove boxes for work with toxic inorganic materials not requiring biological shielding is reviewed as a contribution to this re-examination, with special emphasis on methods and equipment for working safely with plutonium and other α-active materials. An effort is made to point out the direction of current trends in this field. Detailed discussions of glove box designs and methods of experimentation in these enclosures are not included in this report but sufficient information is furnished to enable the reader to decide where to find needed details in the referenced material. Methods for the detection and measurement of α-active materials and of impurities in controlled atmospheres are discussed. In addition, the literature on controlled atmosphere enclosures, glove boxes for nontoxic inorganic materials, and the technique of experimenting with such enclosures is reviewed. ***C. J. Barton.*** *U. S. Atomic Energy Commission, ORNL-3070,* June 14, 1961, 113 pp. (UF767 U3o Contin.)

*** The Vibrational Quadrupole Excitation Model and Non-Axial Rotator Model.** To elucidate the experimental possibilities of checking the nonaxial rotator model and the vibrational model for nuclei with nearly equidistant spectra, a detailed comparison was performed of the predictions of these models for the following quantities: the probabilities of EO-, E2-, E4-, and Ml-transitions of nuclei; isotopic and isomeric shifts of the levels of atomic electrons; quadrupole moments of nuclei in excited states. Experiemnts are proposed to check up the nonaxial rotator model for nuclei in the region of the transition from the equidistant spectrum to that of the axial symmetrical rotator. ***D. P. Grechukhin.*** *Nuclear Physics,* v. 24, no. 4, May 1961, p. 576-600.

OPERATIONS RESEARCH

Analysis for Production Management. This book is oriented toward the analysis of the economic problems of production management. The material is based on a production management course taught at Massachusetts Institute of Technology. ***Edward H. Bowman and Robert B. Fetter.*** 2nd Ed. 562 pp. 1961. Richard D. Irwin, Homewood, Ill. (TS155 B68a)

Exploration in Management. This is a description of the Glacier Metal Company's concepts and methods of organization and management, written by its chairman. He takes the "task" approach to management. In this, both instruments and people are considered, in relation to the work that has to be done. ***Wilfred Brown.*** 326 pp. 1960. John Wiley & Sons, New York. (HD31 B81e).

*** Drive for Status Characterizes Manufacturing Organizations Today.** A depth study of how 31 companies handle manufacturing operations. ***Lester R. Bittel.*** *Factory,* v. 119, June 1961, p. 86-97.

Management—A Look Back and a Look Ahead. The new insight, the concept of management as something specific, came into its own after 1910. Today, we recognize it as a distinct field, "managing" as a profession, "managers" as a special group. Ahead are questions: How shall managers be trained? What are the limits of manageability? ***Peter F. Drucker.*** *Mechanical Engineering,* v. 83, July 1961, p. 27-29.

*** Management and the Productivity of Labor.** Management and labor differ about how productive American labor is, but they agree that the productivity of labor is central to the issues

of wages, prices, inflation, and rate of economic growth. In this, although no one knows for sure what labor productivity means, they are probably right. ***Robert Zager.*** *Advanced Management,* v. 26, June 1961, p. 4-9.

*** Operations Research: A Management Assessment.** Often-misconstrued "O.R." yields incisive, feasible, optional solutions to many posers—some "unsolvable". ***William Lazer.*** *Advanced Management,* v. 26, June 1961, p. 13-17.

Seven Ways to Get Efficiency From Materials Handling. The cost of moving materials involves much more than the price you pay for a lift truck plus the operator's wages. Here's a set of ratios that takes aim on hidden costs. *Iron Age,* v. 187, no. 26, June 29, 1961, p. 67-69.

*** Break-Even Data for Decision Making.** A discussion of the problems encountered by management which determine future growth. *Boxboard Containers,* v. 79, July 1961, p. 51-55.

*** An Inclusive Solution to the Inventory Problem.** Gives a unified approach to a set of inventory problems subsumed under the classical inventory problem proposed by Arrow, Harris, and Marschak. This set includes those problems with periodic reordering, proportional costs and revenues, fixed time lags in receipt of an order, and a static criterion of optimality. ***Arthur Yaspan.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 371-382.

*** Probability Functions for Waiting Times in Single-Channel Queues, With Emphasis on Simple Approximations.** One approach to the waiting-time problem is through the integral equation, whose solution is the cumulative probability function—the method derived by Lindley. The equation is of the type for which a general solution was developed by Wiener and Hopf, and an adaptation of their method is presented in this paper. ***L. R. Saunders.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 351-362.

*** Activity Subdivision and PERT Probability Statements.** The Program Evaluation and Review Technique (PERT) has been developed and implemented as a technique for planning and evaluating the progress of research and development programs. Probability theory is used in PERT to calculate a measure of the uncertainty in meeting scheduled dates. These computed probabilities can then be used by managers to aid their judgment in evaluating the validity of schedules for accomplishing program objectives. This paper investigates the effect of subdividing activities in PERT flow diagrams on computed probabilities for meeting scheduled dates. ***Thomas L. Healy.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 341-350.

*** Application of Dynamic Programming to Countercurrent Flow Processes.** Shows how the methods of dynamic programming may be applied to the problem of optimal design and operation of countercurrent flow processes. ***J. S. Dranoff, L. C. Mitten, W. F. Stevens, L. A. Wanninger, Jr.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 388-401.

*** The Probability Law of the Busy Period for Two Types of Queuing Processes.** A simple combinatorial method is given for the determination of the joint distribution of the length of the busy period and the number of customers served during this period for two types of single-server queuing processes. ***Lajos Takács.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 402-407

*** Queuing With Multiple Poisson Inputs and Exponential Service Times.** Contains an analysis of a single-server queuing system for m different types of customers having independent Poisson arrivals with rates λ_i $i = 1, \ldots, m$ and exponential service times with rates μ_i, $i = 1, \ldots, m$. The discipline is first-come, first-served. ***C. J. Ancker, Jr. and A. V. Gafarian.*** *Operations Research,* v. 9, no. 3, May-June 1961, p. 321-327.

*** Dispersal, Deterrence, and Damage.** Dispersal of alert bombers to large-city airfields has been proposed as a way of improving deterrence by increasing the targets that an enemy first strike would have to destroy, without the cost of constructing new bases. It does, however, make urgent targets out of population centers that might otherwise not be attacked. The improvement in deterrence has to be weighted against the greater damage the enemy would be required to inflict in the event he otherwise could not afford, or would not choose,

to hit cities. This choice cannot be made without giving quantitative weights to alternative outcomes of war, and evaluating alternative probabilities of successful deterrence. The underlying strategic issue is whether general war, if it occurs, necessarily has to be unlimited, indiscriminate, and exhaustive. ***T. C. Schelling.*** *Operations Research*, v. 9, no. 3, May-June 1961, p. 363-370.

Optimum Lot-Size Policy if Tools Break Down Frequently. ***A. R. W. Muyen.*** *Operational Research Quarterly*, v. 12, no. 1, May 1961, p. 41-53.

Application of Dynamic Programming to the Control of Stock and to the Calculation of a Maximum Stock Capacity. Attempts to find out whether, within the framework of a limited and well-defined expansion to level off in 1961, the existing capacity for stocks at a port used for shipping overseas would or would not be sufficient (it was thought it would not be). Study of the model confirmed that the new management rules would make it unnecessary to increase the existing stock capacity. ***E. Ventura.*** *Operational Research Quarterly*, v. 12, no. 1, May 1961, p. 66-78.

Networks of Decentralized Decisions Under Central Management. Criteria for appropriate information are necessary at all levels in order that decentralized decision-making work properly. ***R. W. Bragg and Edward B. Hincks.*** *Aero/Space Engineering*, v. 20, June 1961, p. 14 + 6 pages.

Product Mix for Fringe Benefits. Management must take over the union's role and determine the proper package of fringe benefits for company employees. ***Joseph H. Foegen.*** *Harvard Business Review*, v. 39, no. 4, July-Aug. 1961, p. 64-68.

*** Critical-Path Planning and Scheduling: Mathematical Basis.** Concerned with establishing the mathematical basis of the Critical-Path Method—a new tool for planning, scheduling, and coordinating complex engineering-type projects. The essential ingredient of the technique is a mathematical model that incorporates sequence information, durations, and costs for each component of the project. It is a special parametric linear program that, via the primal-dual algorithm, may be solved efficiently by networks flow methods. ***James E. Kelley, Jr.*** *Operations Research*, v. 9, no. 3, May-June 1961, p. 296-320.

Application of Operations Research for Site Planning Facilities Support. A method of making use of suitable mathematical techniques to pre-analyze and pre-evaluate the various factors important to design solutions, and to analyze and record these evaluations before preliminary design layouts are commenced. ***Phillip J. Daniel.*** *Aero/Space Engineering*, v. 20, June 1961, p. 26 + 5 pages.

ORE AND MATERIALS BENEFICIATION

*** Germanium of High Purity Obtained by Reduction of Germanium Tetrachloride With Hydrogen.** (*In Polish.*) German wysokiej czystości otrzymany przez redukcję wodorem czterochlorku germanu. ***H. Głuchowska and H. Hoffman.*** *Przemysł Chemiczny*, v. 40, no. 4, Apr. 1961, p. 210-211.

*** Cleaning Fine Coal in a 3-Stage Water Cyclone Circuit.** ***J. Visman.*** *Canadian Mining and Metallurgical Bulletin*, v. 54, no. 590, June 1961, p. 442-446.

*** The Agglomeration of Iron Ores and Concentrates.** Methods of agglomerating are discussed. Included are several mixing methods. ***D. J. Hains.*** *Canadian Mining and Metallurgical Bulletin*, v. 54, no. 590, June 1961, p. 430-436.

*** Factorial Design in the Study of Acid Leaching of Pegmatitic Uranium Ores.** An efficient method of studying the effects of changes in process variables, as the required information may be obtained with a minimum expenditure of effort. Establishes base levels of variables for further economic study of U recovery from Higginson Lake pegmatites. ***D. G. Fisher, R. G. McIntosh, R. L. Eager, and A. B. Van Cleave.*** *Canadian Journal of Chemical Engineering*, v. 39, no. 3, June 1961, p. 139-144.

*** Separation of Rare Earths Obtained From Indian Monazite. I. Separation of Ceria & Preparation of Lanthanum & Didymium Concentrates.** A simple and efficient procedure for the continuous separation of pure ceria (+99%) from mixed rare earth chlorides is described and conditions for the preparation of a lanthanum concentrate (80% La_2O_3) and a didymia fraction by hydrolytic precipitation from the filtrate after ceria separation have been established, the methods used for the purpose being hydrolysis with hexamine and precipitation with air-diluted NH_3. ***J. Gupta, S. K. Kundra, and B. R. L. Row.*** *Journal of Scientific & Industrial Research*, v. 20D, Apr. 1961, p. 148-152.

PHYSICS

*** Calculation and Measurement of the Internal Demagnetization Factor.** Reports on the calculation of the magnetic energy and of the lump inner factor of demagnetization of a plurality, distributed in a volume, of small ferromagnetic parts. For the statistic distribution of spherical ferromagnetic particles, the results of the theoretical considerations with measurements of rubber-iron mixtures are compared. (*In German.*) Berechnung und Messung des inneren Entmagnetisierungsfaktors. ***G. Vogler.*** *Annalen der Physik*, v. 7, nos. 5-6, Mar. 1961, p. 268-279.

Stark Broadening of Hydrogenic Ion Lines in a Plasma. The frequency distributions of the ionized helium lines at 4686 A and 3203 A broadened by the local fields of both ions and electrons in a plasma are calculated in the classical path approximation, which is shown to be always applicable. General formulas are developed for the Stark profiles of lines from multiple ionized hydrogenic systems, and the validity domains of the impact and quasi-static approximation for electron and ion broadening are delineated. The results are compared with the Holtsmark theory and an approximation for high series members. ***H. R. Griem and K. Y. Shen.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1490-1496.

Distribution of the Magnetization in a Ferromagnet. The distribution of the magnetization is calculated for a thick ferromagnetic slab with easy axis transverse to the plane of the slab in a large applied field in the plane of the slab. The calculation predicts a stable nonuniform distribution which has several features suggestive of the domain pattern to be expected in such a system. In particular, the pattern consists of alternating strips having approximately the periodicity expected from conventional domain theory; and incipient flux closure domains appear if the anisotropy field is smaller than the demagnetizing field. ***M. W. Muller.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1485-1489.

*** The Angular Dependency of the Magnetic Field-Induced Anisotropy in the Iron-Nickel-Ferrite Solid Solution.** In ferrite materials treated at higher temperatures in a magnetic field, an orientation superstructure is produced under certain conditions, leading to single-axis magnetic anisotropy. In order to study this process in the specimen described, the functional relationship between the moment of rotation and the direction of the magnetic field applied during annealing was measured in the (100)-, (110)- and (111)-plane. Results were compared with known theories based on the pair formation model. (*In German.*) Die Winkelabhängigkeit der magnetfeldinduzierten Anisotropie im Eisen-Nickel-Ferrit-Einkristall. ***Rolf Wagner.*** *Annalen der Physik*, v. 7, nos. 5-6, Mar. 1961, p. 302-311.

*** Temperature Stresses and Optimal Heating Conditions.** The process of cooling of solids of regular geometrical shape is investigated, taking into account maximum temperature stresses. On the basis of this investigation the relationships between maximum relative difference of temperatures and Bi, Ψ, M criteria are obtained. (*In Russian.*) Temperaturnye napriazheniia i optimal'nye usloviia nagrevaniia. ***A. A. Sheveley.*** *Inzhenerno-Fizicheskĭ Zhurnal*, v. 4, no. 4, Apr. 1961, p. 75-79.

*** A Boundary Layer Problem for a Generalized System of Equations of Energy and Substance Transfer.** A solution is found for a generalized system of equations of energy and substance transfer for a half-limited medium in a three-dimensional

space with boundary conditions of the second type. The problem is solved by applying a Fourier transform along the space coordinates and a Laplace transform in time. The case where boundary and initial conditions are constant is considered. (*In Russian.*) Kraevaia zadacha dlia obobshchennoi sistemy uravnenii perenosa energii i veshchestva. ***P. V. Tsoi.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 4, Apr. 1961, p. 69-74.

Lectures in Theoretical Physics. Lectures delivered at the Summer Institute for Theoretical Physics, University of Colorado, Boulder, 1960, on causality and dispersion relations; statistical mechanics of irreversibility; the scattering of electrons by atoms; some applications of the generating functional of the molecular distribution functions; nonequilibrium statistical mechanics; quantum theory of collision processes; canonical commutation relations in field theory and functional integration; general theory of nonequilibrium phenomena; Martin-Schwinger methods in the many-body problem; and Green's functions and the quantum theory of fields. ***Wesley E. Brittin, B. W. Downs, and Joanne Downs, editors.*** v. III. 531 pp. 1961. Interscience Publishers, New York. (QC3 C71L)

* **Stability of Plasma.** Review. (*In Russian.*) Ustoichivost plazmy. ***A. A. Vedenov, E. P. Velikhov, and R. Z. Sagdeev.*** *Uspekhi Fizicheskikh Nauk,* v. 73, no. 4, Apr. 1961, p. 701-766.

* **Plasma Movement in Crossed Electrical and Magnetic Fields.** Studies some special cases of plasma movement in these types of fields under steady and unsteady conditions with calculation of the adhesivities. Formulas suitable for analysis and calculation were obtained and graphics of the dependence of the speed of motion on the value of the external magnetic field were drawn. An evaluation of the "induction saturation" of the speed of motion in an intense magnetic field was made. (*In Russian.*) O dvizhenii plazmy v skreshchennykh elektricheskom i magnitnom poliakh. ***A. K. Musin.*** *Radiotekhnika i Elektronika,* v. 6, no. 5, May 1961, p. 770-778.

* **Regular Thermal Behaviour in a Cylinder.** The upper and lower estimates are given of the remainder of a series representing the solution of the heat-conduction problem without the first term. With the use of this estimate, the time when regular conditions set in the infinite cylinder as a whole and in any part of it, can be found. (*In Russian.*) O reguliarnom teplovom rezhime v tsilindre. ***K. K. Volkova.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 5, May 1961, p. 21-26.

* **Study of the External Heat and Mass Transfer During the Liquid Evaporation From a Capillary Porous Body.** Presents results of the experimental investigation of external heat and mass transfer in the period of a constant velocity of the convective drying. Simultaneously heat transfer of a dry body was investigated. (*In Russian.*) Issledovanie vneshnego teplo-i massoperenosa pri isparenii zhidkosti kapilliarno-poristym telom. ***G. T. Sergeev.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 5, May 1961, p. 33-37.

* **The Distribution of Temperature Near a Rotating Thermally Insulated Disc.** A calculation is made for the distribution of temperature near a disc rotating in a viscous noncompressible liquid for the laminer flow, where there is no heat exchange on the disc surface. (*In Russian.*) Raspredelenie temperatury vblizi vrashchaiushchegosia teploizolirovannogo diska. ***L. A. Dorfman.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 5, May 1961, p. 38-43.

* **The Determination of Thermal Constants by the Temperature Waves Method.** A method for measuring thermal constants is proposed. A long cylindrical model is placed in a medium whose temperature changes according to a periodic law. Thermal diffusivity is determined as the ratio of the amplitude of temperature fluctuations along the axis to the amplitude at a certain distance from the axis in the central part of the model: (*In Russian.*) Opredelenie Teplofizicheskikh koeffitsientov metodom temperatur nykh voln. ***Iu. A. Kirichenko.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 5, May 1961, p. 12-15.

* **The Calculation of Temperature and Sorptive Capacity for the Case of Inner Heat Generation.** The effect of energy of radioactive radiation in a sorbent on temperature and sorptive capacity is considered. A differential equation is derived for the distribution of temperature over a long cylindrical tube filled with absorbent, the relationship between the density of

heat sources and temperature being taken into account. (*In Russian.*) Raschet temperatury i emkosti adsorbenta pri nalichii vnutrennikh istochnikov tepla. ***N. I. Buleev, V. N. Vvedenskii, I. E. Nakhutin, and V. K. Pyshin.*** *Inzhenerno-Fizicheskĭi Zhurnal,* v. 4, no. 5, May 1961, p. 8-11.

* **Quantum Statistics of Interacting Electron Gas in a Strong Magnetic Field.** The quantum statistical mechanical propagator which has been introduced by Matsubara is calculated by using the free electron eigenfunction in a magnetic field. This form of the propagator seems to be appropriate for the treatment of the oscillatory behaviors of magnetic properties of the interacting electron gas. As a tentative application of this method, the effect of the Coulomb interaction between electrons on the de Haas-van Alphen effect is discussed. ***Hiroshi Ichimura and Setsuko Tanaka.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 315-326.

* **Unified Gravitational and Electromagnetic Waves.** Starting with a very general form of the nonsymmetric tensor g_{ik} expressed in a coordinate system suitably chosen to obtain wave solutions, a scheme is developed to derive rigorous solutions of the field equations of Einstein which describe the flow of unified gravitational and electromagnetic radiation. Several such solutions are derived, giving waves with two-dimensional symmetry. It is found that solutions describing gravitational and electromagnetic waves obtained in the general theory of relativity with the help of an energy momentum tensor, can be derived in exactly the same form from the geometrical theory of the unified law of inertia enunciated by Hlavaty. ***P. C. Vaidya.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 305-314.

* **Domain Structure of Ferromagnetic Films Obtained by Cathodic Pulverization.** Tests revealed that materials with any melting temperature can be subjected to cathodic pulverization; it is possible to obtain films of different thickness under well controlled conditions; uniformity of pulverization and sufficient rate of production of the films are guaranteed; films are obtained which differ only slightly from the composition of the initial materials. Such alloys as Fe-Ni, ferrosilicon, and others were involved. (*In Russian.*) O domennoĭ strukture ferromagnitnykh plenok, poluchaemukh katodnym raspyleniem. ***G. V. Spivak, I. G. Sirotenko, and R. D. Ivanov.*** *Akademiia Nauk SSSR, Izvestiia, Seriia Fizicheskaia,* v. 25, no. 5, May 1961, p. 581-583 + 1 plate.

* **Domain Boundaries in Thin Ferromagnetic Films.** Double boundaries in thin ferromagnetic films of Fe, Co, and of an alloy containing 80% Ni, 17% Fe and 3% Mo, are Bloch boundaries of opposite polarity. The Bloch boundaries in thin ferromagnetic films have alternating polarities, which makes it possible to determine the presence of such boundaries by the superposition of a normal pole and by changing its sign. With decreasing thickness of the film, beginning from a sign depending on the composition of the film, boundaries of the Neel type are formed. (*In Russian.*) O granitsakh domenov v tonkikh ferromagnitnykh plenkakh. ***L. V. Kirenskiĭ and V. A. Buravikhin.*** *Akademiia Nauk SSSR, Izvestiia, Seriia Fizicheskaia,* v. 25, no. 5, May 1961, p. 574-576.

* **Absolute Intensities of Electron Migrations in Diatomic Molecules.** Studies the connection between the magnitudes determining the intensity of the electron passage, the theoretical calculation of oscillator forces of diatomic molecules and their experimental determination. (*In Russian.*) Absoliutnye intensivnosti elektronnykh perekhodov v dvukhatomnykh molekulakh. ***V. N. Soshnikov.*** *Uspekhi Fizicheskikh Nauk,* v. 74, no. 1, May 1961, p. 61-85.

Wave Functions for the Free Electron. II. The Inclusion of Polarization and Exchange. ***R. G. Breene, Jr.*** *General Electric Company, Technical Information Series,* No. R60SD478, Dec. 1960, 29 pp. (T1 G28t Contin.)

Experimental Performance of a Pulsed Gas Entry Coaxial Plasma Accelerator. Construction and operation of two coaxial types of accelerator are discussed. The results of some preliminary evaluations of their performance are given. Description is included of a large vacuum testing tank under construction for simulation of outer space conditions on repetitively pulsed plasma accelerators. ***P. Gloersen, B. Gorowitz, and W.***

Palm. General Electric Company, Technical Information Series, No. R61SD042, Apr. 1961, 26 pp. (T1 G28t Contin.)

* **Phase Shift and Identities in Quantized Field Theory.** Points out certain basic relations between the phase shifts and the energy spectrum which we illustrate in simple examples. Several applications of these relations are considered: a determinant form for the S-matrix is found; *n*-body forces in the static pair-coupling theory are evaluated; some properties of the *g*-derivative of the phase shift are discussed, and a covariant method for the construction of nuclear force is proposed. **Shûkô Azuma.** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 381-403.

* **Dispersion Relations and High Energy Limits in Quantum Field Theory. II.** The lower and upper bounds of the high energy limit of pion-nucleon forward scattering amplitudes are investigated. The former is studied, using available experimental data, and found that at least one subtraction is necessary in the dispersion relations. The latter can be determined under an additional requirement that the forward amplitude has no zero in the complex energy plane. Some discussions are given to the problems on the high-energy behaviors in quantum field theories. ***Seiya Aramaki.*** *Progress of Theoretical Physics,* v. 25, no. 3, Mar. 1961, p. 404-410.

* **The Polarity of the Diatomic Molecule.** The relation between the ionicity of the bond and the electronegativity difference is discussed by the use of the semi-localized orbital method. It is found that the ionicity of the bond depends not only on the electronegativity difference, but also on the overlap integral between the atomic valence orbitals. According to the magnitude of the overlap integral, the diatomic molecules are divided into the two groups which show the different features with respect to the dependence of the ionicity of the bond on the electronegativity difference. ***Kiyosi O-Ohata.*** *Progress of Theoretical Physics,* v. 25, no. 2, Feb. 1961, p. 215-228.

* **Hydrodynamic Shockwaves on a Linear Pinch.** The purpose of the experiments was to achieve hydromagnetic shockwaves on a linear pinch collapse. To approach the hydromagnetic two-fluid model a strong pre-ionization was used. If the conductivity of the plasma is high and the gas fully ionized, the mass density must be proportional to the stabilizing field within the current sheet. By this way the structure of shockwaves could be obtained from magnetic field measurements. (*In German.*) Hydrodynamische Stosswellen am linearen Pinch. ***W. Köppendörfer.*** *Zeitschrift für Naturforschung,* v. 16a, May 1961, p. 484-491.

Band-Splitting in the Spectra of Cubic Crystals Subjected to Oriented Deformation. Investigates the amount of splitting of the spectral bands associated with anisotropic centers in cubic crystals subjected to deformation along certain crystallographic directions. ***A. A. Kaplyanskii.*** *Optics and Spectroscopy* (Cover-to-cover translation of *Optika i Spektroskopiia*), v. 10, no. 2, Feb. 1961, p. 83-87.

* **Centrifugal Distortion in Planar Molecules.** The rotational distortion of a general asymmetric top molecule is described by six rotational distortion constants which are functions of nine constants appearing in the first-order Hamiltonian for the nonrigid rotor. Shows that for the case of a planar asymmetric top molecule these nine constants reduce to four, so that the centrifugal distortion of a planar asymmetric top molecule can be described by four constants rather than the usual six. It is also shown for planar symmetric top molecules that only two constants are required to describe the centrifugal distortion effects, rather than the usual three. ***Jerome M. Dowling.*** *Journal of Molecular Spectroscopy,* v. 6, no. 6, June 1961, p. 550-553.

* **Optical Calibration of Vibration Pickups at Small Amplitudes.** A photometric device for accurately measuring the amplitudes of sinusoidal vibrations is described. The device is designed for calibrating vibration pickups. The apparatus employs a Fizeau-type interferometer with a photomultiplier observing the fringe pattern. The method is applied to the measurement of vibrations throughout the audio and near ultrasonic frequency range with amplitudes ranging from 72 to 4400 A. Extension to amplitudes as low as 5 A can be made with some modification to the apparatus. ***V. A. Schmidt, S. Edelman, E. R. Smith, and E. Jones.*** *Acoustical Society of America, Journal,* v. 33, June 1961, p. 748-751.

* **Volume Per Seat and Variation of the Reverberation Time With the Size of the Audience.** A maximum relative variation of the reverberation time according to the size of the audience must be stated as a design condition for a hall together with the value of the reverberation time itself (for instance, 1.3 sec at 500 cps, ± 10%). It is interesting and very useful to compute, quantitatively, how a change in the type of seats, the volume of the hall, or the number of seats would affect the relative variation in the reverberation time according to the number of occupied seats. The present work gives, in the form of equations and charts, an easy way to do this. ***Jaime R. Carbonell and José L. Zuccoli.*** *Acoustical Society of America, Journal,* v. 33, June 1961, p. 757-759.

* **Utilization of Magnetostrictive Materials in Generating Intense Sound.** The intense sound output at resonance in a laminated nickel bar is calculated from static measurements of the relationship of the free magnetostrictive strain to the intrinsic induction. The limitations of the linear theory are avoided by determining the dynamic magnetostrictive stress which is taken to be the motivating influence of the mechanical vibrations. The dynamic magnetostrictive stress is obtained by graphical methods that are not limited to small excitation amplitudes, as is the case in the linear theory. Simple relationships of the dynamic magetostrictive stress to the impedances of the transducer-load system enable the sound output to be determined from the calculated magnitudes of the magnetostrictive stress. ***R. R. Whymark.*** *Acoustical Society of America, Journal,* v. 33, June 1961, p. 725-732.

* **Optical Measurement of Ultrasonic Fields.** An apparatus is described which facilitates the measurement of ultrasonic fields within transport solids. This optical system makes use of the birefringence produced within the solid by the passage of an ultrasonic wave. The interaction of light with ultrasonic fields is discussed and expressions derived for the modulation of light by both transverse and longitudinal ultrasonic waves. Various detection systems are discussed and the reasons for the choice of a system, making use of a wide slit in conjunction with a pulsed ultrasonic source, are given. An electronic apparatus, assembled for the most part from commercially available components to implement the measurement, is described. The output of the system is a strip-chart recording of the strength of the ultrasonic field along a line. The advantages and limitations of the electronic system are discussed. A typical measurement made with the apparatus is shown and suggestions are given to extend the range of the apparatus. ***Richard F. Weeks.*** *Acoustical Society of America, Journal,* v. 33, June 1961, p. 741-747.

* **Energy Bands of the Periodic Lattice of the Se Type.** The band structure of the periodic chain lattice was studied for the nearly cubic borderline case in the Bloch approximation and the result was compared with that of Reitz for the extreme periodic chain lattice. For the two borderline cases there was the same pattern of *p* bands in the chain direction, so that it was easy to interpolate. (*In German.*) Über die Energiebänder der Kettengitter vom Selen-Typ. ***Ernst Behrens.*** *Zeitschrift für Physik,* v. 163, no. 2, 1961, p. 140-143.

* **Scattering of Subthermal Neutrons in H_2O, CH_2O_2 and C_6H_6.** The total effective cross section of these compounds were determined within the range of the subthermal neutron energies of $0.2 \cdot 10^{-3}$ to $2.7 \cdot 10^{-3}$ eV and at $36 \cdot 10^{-3}$ eV as a function of the neutron energy and of the substance temperature in the region of all the three aggregate states. The gradual decrease at the boling point during melting is due especially to the elimination of the rotation obstacle of the molecule during evaporation. (*In German.*) Streuung subthermischer Neutronen an H_2O, CH_2O_2 und C_6H_6. ***Klaus Heinloth.*** *Zeitschrift für Physik,* v. 163, no. 2, 1961, p. 218-229.

* **A Contribution to the Resistance Behavior of Very Thin Bismuth Layers Especially During the Adsorption of Oxygen.** Describes a method of producing especially gas-poor thin layers in high vacuum. The method is suitable for metals which evaporate in sufficient amount below 800 C approximately. Bismuth layers made at 140 K exhibit during O adsorption a decrease of their resistance up to seven-tenth powers with initial values of about 10^{10} Ω. It was possible to explain this phenomenon with electricity by the tunnel effect between individual metal islands. (*In German.*) Zum Widerstandsver-

halten sehr dünner Wismutschichten, insbesondere bei der Adsorption von Sauerstoff. ***Werner Ort.*** *Zeitschrift für Physik*, v. 163, no. 2, 1961, p. 230-239.

*** Electrodynamics of Media With Spatial Dispersion.** Studies equations of the electromagnetic field, a tensor of complex specific inductive capacitance, the dispersion of this tensor, the energy of the electromagnetic field in the medium, plane monochromatic waves in the medium, the propagation of electromagnetic waves in media with low spatial dispersion, and the losses of energy of rapid electrons in the medium. (*In Russian.*) Elektrodinamika sred s prostranstvennoĭ dispersieĭ. ***A. A. Rukhadze and V. P. Silin.*** *Uspekhi Fizicheskikh Nauk*, v. 74, no. 2, June 1961, p. 223-267.

*** The Damping of Particle Oscillations in a General Field With Periodic Structure. I.** A linear theory is derived, discussing the dynamics of particles in the region of an equilibrium orbit in a general electromagnetic field, which forms a periodic system. The total particle damping is determined from the Hamiltonian and from dissipative forces brought out by a classical reaction radiation. Relations for the damping of the synchrotron oscillations are derived from the study of the appropriate phase space. (*In Russian.*) Zatykhanie kolebaniĭ chastits v obshchem pole s periodicheskoĭ strukturoĭ. I. ***J. Teichman and R. Klíma.*** *Czechoslovak Journal of Physics*, v. 11, no. 5, 1961, p. 307-319.

*** State of the Polarization Theory of Ideal Ion and Valence Crystals.** Studies the noninertial theory of polarization on the basis of a lattice model of point dipoles with determination of the internal field; the inertial theory of crystal polarization in a model of point ions and dipoles, and the deficiencies of the theory; methods to improve the lattice theory, taking into account the final dimensions of the ions; the quantum mechanics basis of the dynamics of the crystal lattice and an adiabatic approximation; the nearest problems of the crystal polarization theory. (*In Russian.*) Sostoianie teorii poliarizatsii ideal'nykh ionnykh i valentnykh kristallov. ***K. B. Tolpygo.*** *Uspekhi Fizicheskikh Nauk*, v. 74, no. 2, June 1961, p. 269-288.

Polarization of Phosphorescence in Organophosphors. The anisotropy of the afterglow and total luminescence of organophosphors is studied. A variation in the degree of polarization of β-phosphorescence in the emission spectrum was found for all the compounds investigated. ***V. A. Pilipovich.*** *Optics and Spectroscopy* (Cover-to-cover translation of *Optika i Spektroskopiia*), v. 10, no. 2, Feb. 1961, p. 104-107.

Role of the Stimulating Action of Exciting Light in the Kineties of Luminescence of ZnS:Cu Crystalline Phosphors. Shows that when exciting light frees electrons from traps in the ZnS:Cu phosphor, this results in a decrease of electron concentration in deep traps as the intensity of excitation increases. After the excitation stops, the distribution of electrons among traps gradually approaches the equilibrium value. ***L. A. Vinokurov and M. V. Fok.*** *Optics and Spectroscopy* (Cover-to-cover translation of *Optika i Spektroskopiia*), v. 10, no. 2, Feb. 1961, p. 112-115.

*** Theory of Polaron Mobility.** The polaron mobility is calculated by making use of the general theory of electrical conductivity. The states determined by Feynman's trial action as the unperturbed states are taken and the difference between the true action and the trial action as a perturbation are treated. Numerical values of the polaron mobility at very low temperatures are given and are discussed in comparison with the results obtained by Schultz and by Morita. ***Yukio Osaka.*** *Progress of Theoretical Physics*, v. 25, no. 4, Apr. 1961, p. 517-536.

*** Investigation of Preparatory Effects on the Luminescence Properties of ZnSCu.** For the blue-green transformation of the ZnSCu emission the quality of the precipitated Zn sulfide is of the highest importance. The thermal after-treatment of the different phosphori has a definite effect on the insertion mechanism of the activators and thus on the emission. For the ZnSCu P there are three regions of temperature within which the green-emitting Cu insertion is preferred. (*In German.*) Untersuchungen über präparative Einflüsse auf die Leuchteigenschaften von ZnSCu. ***H. Ortmann.*** *Zeitschrift für Physikalische Chemie* (Leipzig), v. 216, nos. 1-4, 1961, p. 75-83.

*** Velocity of Sound and Molecular Structure. I. Some General Considerations Concerning the Molecular Kinetic Evaluation of the Velocity of Sound in Liquids. II. A Contribution to the Study of the Functional Relationship Between Temperature and the Velocity of Sound. III. The Velocity of Sound and the Potential of the Intermolecular Forces.** (*In German.*) Schallgeschwindigkeit und Molekülstruktur. I. Einige allgemeine Gesichtspunkte zur molekularkinetischen Berechnung der Schallgeschwindigkeit in Flüssigkeiten. II. Zur Temperaturabhängigkeit der Schallgeschwindigkeit. III. Die Schallgeschwindigkeit und das Potential der zwischenmolekularen Kräfte. ***K. Altenburg.*** *Zeitschift für Physikalische Chemie* (Leipzig), v. 216, nos. 1-4, 1961, p. 127-162.

Flashlike Rise of Luminescence. II. ZnS-Co and ZnS-Ag,Co Phosphors. The nature of the phenomenon is shown to be connected specifically with the kind of activator present. ***N. A. Tolstoi, et al.*** *Optics and Spectroscopy* (Cover-to-cover translation of *Optika i Spektroskopiia*), v. 10, no. 2, Feb. 1961, p. 90-92.

A Model Designed to Predict the Motion of Objects Translated by Classical Blast Waves. A theoretical model was developed for the purpose of predicting the motion of objects translated by winds associated with "classical" blast waves produced by explosions. Among the factors omitted from the model for the sake of simplicity were gravity and the friction that may occur between the displaced object and the surface upon which it initially rested. Numerical solutions were obtained (up to the time when maximum missile velocity occurs) in terms of dimensionless quantities to facilitate application to specific blast situations. The results were computed within arbitrarily chosen limits for blast waves with shock strengths from 0.068 to 1.7 atm (1 to 25 psi at sea level) for displaced objects with aerodynamic characteristics ranging from those of a human being to those of 10-mg stones and for weapon yields at least as small as 1 kt or as large as 20 Mt. ***I. Gerald Bowen, Ray W. Albright, E. Royce Fletcher, and Clayton S. White.*** *U. S. Atomic Energy Commission, CEX-58.9*, June 29, 1961, 55 pp. (UF767 Un3.1cex Contin.)

*** A New Approach to the Theory of Classical Fluids. III.** A classical system enclosed in a finite volume and exerted by external forces is treated in quite a general way. The main results, which may be applicable to solids as well as to fluids, are given. Exact integral equations are found for the one- and two-particle distribution functions. Some thermodynamic functions are expressed in terms of these distribution functions. It is shown that there exist variational principles saying that the grand partition function is to be maximum with respect to the variations in the one- and two-particle distribution functions. Variational principles are found also for the Helmholtz free energy. It is suggested that Mayer's theory of condensation may in fact give the end point of the metastable gaseous state. It is pointed out that the hyper-netted chain approximation, proposed previously by one of the present authors, has a meaning in solids as well as in fluids. ***Tohru Morita and Kazuo Hiroike.*** *Progress of Theoretical Physics*, v. 25, no. 4, Apr. 1961, p. 537-578.

Magneto-Resistance in Superfluid Liquid Helium. In the presence of a magnetic field the system becomes dissipative. Thus in contradistinction to the situation in solids, the magnetoresistance effect in helium II corresponds to the actual creation of a scattering mechanism, and appears as a fundamental phenomenon to the determination of an order of magnitude of the magnetoresistance effect. For this purpose, it will be sufficient to evaluate a relaxation time describing the approach to equilibrium of a system of ions in liquid helium II. ***G. Severne.*** *Physica*, v. 27, no. 5, May 1961, p. 465-478.

Coherence Properties of Electromagnetic Radiation. Conference report (June 1960, sponsor: U. S. Air Force, Optical Society of America, and Univ. of Rochester) discusses investigations by various observers into the phenomenon of coherence in electromagnetic radiation. Coherence within the source and within a single atom is discussed. ***E. L. O'Neill and L. C. Bradley.*** *Physics Today*, v. 14, June 1961, p. 28-34.

*** Disturbances Caused by Mercury in the Study of the Adsorption of Gases by Very Thin Platinum Layers.** Compares the variations of electric resistance by adsorption of H at 77.4 K of Pt deposits prepared either in a highly evacuated

container or in a container using Hg pumps and valves. In the first container the resistance increases and then decreases gradually in a reproducible way. In the second container the results are only slightly reproducible and display the conditions of abnormal Hg adsorption leading to important decrease in resistance. (*In French.*) Perturbations causées par le mercure dans l'étude de l'adsorption des gaz par des couches très minces de platine. ***Sen Sik Minn, Suzanne Offret, and Boris Vodar.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 22, May 29, 1961, p. 3445-3447.

PLASTICS

*** Graft Copolymers of *p*-Isopropylstyrene and Methyl Methacrylate.** The preparation of a completely isopropylated polystyrene by polymerization of *p*-isopropylstyrene monomer is described. This polymer was autoxidized in cyclohexane with lauroyl peroxide to give a material of good reproducibility and high purity. Methyl methacrylate was successfully grafted to the polymeric hydroperoxide by using a sugar-containing recipe. Homopolymer was separated from the graft copolymer by extraction. Evidence for grafting was obtained from solubility and fractionation behavior, as well as from light-scattering and viscosity measurements. ***J. D. Matlack, S. N. Chinai, R. A. Guzzi, and D. W. Levi.*** *Journal of Polymer Science,* v. 49, Feb. 1961, p. 533-541.

*** Study of the Chemical Structure of a Spongy Diisopropenyl Polymer.** This polymer is formed by the combination of diisopropenyl molecules in the following position -1,4 - 1,4-. In the products of ozonolysis of the spongy diisopropenyl polymer, no substances indicating the branched structure of this polymer are found. (*In Russian.*) Izuchenie khimicheskogo stroeniia gubchatogo polimera diizopropenila. ***A. I. Spasskova and E. F. Rozanov.*** *Zhurnal Obshcheĭ Khimii,* v. 31(93), no. 5, May 1961, p. 1505-1508.

*** Epoxy Resin Repairs Save Pump Diffuser Section $.** Epoxy-coated condenser equipment is protected against corrosion. ***Stanley Rogers.*** *Electric Light and Power,* v. 39, no. 7, Apr. 1, 1961, p. 36-37.

Viscoelastic Properties of Polymers. A discussion is given of the phenomenological theory of viscoelasticity followed by the presentation of a wide variety of experimental methods and a critical appraisal of their applicability to polymeric materials of different characteristics. The existing state of molecular theory is reviewed and used to interpret the effects of temperature, chemical structure, dilution (plasticization), and other variables. ***John D. Ferry.*** 482 pp. 1961. John Wiley & Sons, New York. (QC191 F41v)

*** Rigid Moltopren, a Polyurethane for Thermal Insulation.** The position with regard to the production of Moltopren foam is discussed, followed by details of raw material development in recent years. Most important in this field is the use of new blowing agents and a new type of polyisocyanate. It means that mechanical and above all, thermal-insulation properties can be considerably improved. (*In German.*) Hartes Moltopren, ein Polyurethan-Schaum für die Kälte- und Wärmeisolierung. ***F. K. Brochhagen.*** *Kunststoffe,* v. 51, May 1961, p. 246-251.

*** The Preparation and Polymerization of Some Long-Chain Mono-, Di- and Triolefins With Metal Coordination Catalysts.** Methods of synthesis for 1,*cis*-9-octadecadiene, 1,*trans*-9-octadecadiene, 1,*cis*-9-*cis*-12-octadecatriene, 1,9,12-octadecatriene with 56% *trans* unsaturation, and several necessary intermediates are described. ***C. S. Marvel and John R. Rogers.*** *Journal of Polymer Science,* v. 49, Feb. 1961, p. 335-352.

*** Two Flexible Epoxy Resins.** The advent of two new reactive epoxy modifiers promises new latitude in formulating. Both are diglycidyl ethers of aliphatic glycols, and both contribute toughness or outright flexibility to any epoxy system in which they appear. These new epoxy additives contribute more than just flexibility. They have excellent color and very low viscosity, indicating that they may be efficient reactive diluents where the flexibility contribution is of little or no concern. ***R. F. Helmreich and L. D. Harry.*** *SPE Journal,* v. 17, June 1961, p. 583-586.

*** Decorating of Plastics.** Spray coating, spray and wipe, silk screening, and vacuum metallizing are considered. Applications, limitations and advantages of each of these methods are discussed. ***T. E. Hayden and John Scharnberg.*** *SPE Journal,* v. 17, June 1961, p. 576-579.

*** Absorption of Aqueous Vapors by Hydrophilic High Polymers. IV. Sorption Isotherms and Heats of Moistening of Pulverized Polymer Mixtures. V. Sorption Isotherms and Heat of Moistening of Collagen and of the Products of Its Chemical Treatment.** (*In Russian.*) Sorbtsiia vodianykh parov gidrofil'nymi vysokopolimerami. IV. Izotermy sorbtsii i teploty smachivaniia smeseĭ polimerov, obrazuiushchikh muku. V. Izotermy sorbtsii i teploty smachivaniia kollagena i produktov ego khimicheskoĭ obrabotki. ***E. F. Nekriach.*** *Ukrainskiĭ Khimicheskiĭ Zhurnal,* v. 27, no. 3, 1961, p. 326-335.

*** The Kinetics of Aqueous Polymerization of Acrylonitrile.** The kinetics of the aqueous polymerization of acrylonitrile initiated by the redox pair, potassium persulfate-sodium hydrosulfite, have been investigated. The reciprocal of the induction period has been found to vary linearly with the product of the concentrations of the redox components. The initial rate of polymerization shows square root dependence on the initiator concentration, while the rate afterwards rises with rising initiator concentration, and ultimately falls with further increase in the initiator concentration. The degree of polymerization rises at first with increasing initiator concentration, and then falls, running more or less parallel to the rate. ***Mukul Biswas and Santi R. Palit.*** *Journal of Scientific & Industrial Research,* v. 20B, Apr. 1961, p. 160-165.

*** Stereoregular Polymers. VII. Infrared Spectra of Isotactic Polystyrene, Isotactic Poly-α,β,β-trideuterostyrene and Isotactic Poly-p-deuterostyrene.** ***Hiroyuki Tadokoro, Yoshiyuki Nishiyama, Shun'ichi Nozakura, and Shunsuke Murahashi.*** *Chemical Society of Japan, Bulletin,* v. 34, no. 3, Mar. 1961, p. 381-391.

*** Crystallization and Melting of Different High Polymers According to Radiographic Measurements.** Due to the special structure of the macromolecule, anisotropic crystal structures exist which, as a rule, are included during the crystallization of tempered specimens. The crystallization of the polymers studied can be checked partly or entirely by the tempering process. The causes of the gradual crystallization of the polymers during tempering were discussed. The increase of long period during the structural change from pseudostructure to crystal structure was attributed to the selective melting of the smallest particles with simultaneous growth of the stable crystals. (*In German.*) Kristallisieren und Schmelzen von verschiedenen Hochpolymeren nach röntgenographischen Messungen. ***H. G. Kilian.*** *Kolloid-Zeitschrift,* v. 176, no. 1, May 1961, p. 49-62.

*** Polybenzimidazoles, New Thermally Stable Polymers.** Wholly aromatic polybenzimidazoles were synthesized from aromatic tetraamines and difunctional aromatic acids and characterized as new thermally stable polymers. The melt polycondensation of aromatic tetraamines and the diphenyl esters of aromatic dicarboxylic acids was developed as a general procedure of wide applicability. Polybenzimidazoles containing mixed aromatic units in the chain backbone were prepared from 3,3'-diaminobenzidine, 1,2,4,5-tetraaminobenzene and a variety of aromatic diphenyl dicarboxylates. Phenyl 3,4-diaminobenzoate could also be polymerized by melt condensation to give poly-2,5(6)-benzimidazole. The polymers were characterized by a high degree of stability, showing great resistance to treatment with hydrolytic media and an ability to withstand continued exposure to elevated temperatures. Most of the polymers were infusible, but some had melting points above about 400 C. Many of the polymers exhibited no change in properties on being heated to 550 C and showed a weight loss of less than 5% when heated under nitrogen for several hours to 600 C. The polymers were soluble in concentrated sulfuric acid and formic acid, producing stable solutions. Many of the polymers were soluble in dimethyl sulfoxide and some also in dimethylformamide. The inherent viscosities of a number of polymers in 0.5% dimethyl sulfoxide solution ranged from approximately 0.4 to 1.1. The higher polymers could be cast into stiff and tough films from formic acid and dimethyl sulfoxide solutions. ***Herward Vogel and C. S. Marvel.*** *Journal of Polymer Science,* v. 50, Apr. 1961, p. 511-539.

* **Differential Thermal Analysis of High Polymers. II. Effects of Diluents on Melting Behavior of Polyethylenes. III. Polyamides.** II. ***Bacon Ke.*** III. ***Bacon Ke and A. W. Sisko.*** *Journal of Polymer Science,* v. 50, Mar. 1961, p. 79-98.

* **Effects of Irradiation and Rolling on the Tensile Behavior of Polyethylene.** Tensile properties of low-pressure polyethylene subjected to both irradiation and rolling have been studied. The anisotropic properties induced by rolling and irradiation were measured by testing the tensile behavior of specimens cut at 0°, 45°, and 90° to the direction of rolling. The yield strengths of specimens cut parallel to the direction of rolling increased with increasing reduction in thickness, but the yield strengths of those cut at 45° and 90° were scarcely affected. ***Yoshinori Tsunekawa, Moriya Oyane, and Kohei Kojima.*** *Journal of Polymer Science,* v. 50, Mar. 1961, p. 35-44.

* **Adhesion of Polymers. VIII. Adhesion to Polyamide of Graft and Modified Polymers Synthesized on the Basis of Carboxyl-Containing Butadienestyrene Rubbers (KBSK) and ε-Caprolactam, Itself, and Its Derivatives.** The adhesion to polyamide of graft and modified polymers prepared on the basis of carboxy-butadienestyrene rubbers and ε-caprolactam and its derivatives has been investigated. Such modification of the rubber somewhat lowers its adhesive properties at room temperature. The adhesion sharply increases, however, on raising the contact temperature, attaining values above the cohesive strength of the original materials. The effect of some specific features of the graft polymers upon their adhesion to polyamide has been shown. Experiments have shown that the strength of the bond between rubber and capron fabric impregnated with a solution of the graft polymers is about twice that for untreated fabric. It has been indicated that graft polymers may be utilized in practice for enhancing bond strength between rubber and polyamide fabrics. (*In Russian.*) Adgeziia polimerov. VIII. Adgesiia k poliamidu privtykh i modifitsirovannykh polimerov, poluchennykh na osnove karboksilosoderzhashchikh butadienstirol'nykh kauchukov ε-kaprolaktama i ego proizvodnykh. ***V. L. Vakula, I. A. Tutorskiĭ, N. I. Smelaia, Z. Smelyĭ, and S. S. Vaiutskiĭ.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 775-782.

* **Free Radical Polymerization of Ethylene. II. Kinetics of Ethylene Polymerization in Benzene and Heptane.** The kinetics of azoisobutyronitrile-induced polymerization of ethylene have been studied. Experiments were carried out at monomer concentrations up to 7.66 mole/l and temperatures 50 to 70°. The reaction order in benzene and heptane with respect to ethylene was found to be 1.25 and 1.0, respectively, and with respect to the initiator 0.51. The following transfer constants have been obtained: for ethylene 5×10^{-5}, for benzene 1.8×10^{-3} and for heptane 9.0×10^{-3}. The activation energy of ethylene polymerization is 20 kcal/mole. (*In Russian.*) Polimerizatsiia etilena pod vliianiem svobodnykh radikalov. I. Kinetika polymerizatsii etilena v pastvore v benzole i geptane. ***S. G. Liubetskiĭ, B. A. Dolgoplosk, and B. L. Erusalimskiĭ.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 734-739.

* **Cyclic Polymerization. I. N-Methyldimethacrylamide.** The peroxide initiated polymerization of N-methyldimethylacrylamide (MDMA) in block and in benzene, toluene and dimethylformamide solutions has been investigated. A soluble, fusible polymer has been shown to form, not containing unsaturated properties (as confirmed by the bromide-bromate method and the IR-adsorption spectra). (*In Russian.*) Tsiklicheskaia polimerizatsiia. I. N-Metildimetakrilamid. ***T. A. Sokolova and G. D. Rudkovskaia.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 706-710.

* **Studies in Polymer Synthesis. I. Synthesis of Polyamides on the Basis of Xylylenediamines.** The polycondensation of *m*- and *p*-xylylenediamines with various aliphatic and aromatic dicarboxylic acids has been investigated, and the properties of the resultant polyamides have been described. For most of the specimens, conditions have been found for the preparation of high-molecular polyamides with high-melting temperatures and with the ability of forming strong fibers. In the reaction between xylylenediamines and phthalic acid the principal product was found to be the corresponding diphthalylxylylene-diamines; high molecular compounds did not form due to termination of the phthalic acid chain by formation of the cyclic imide. The conditions for the preparation of the neutral salts of *m*- and *p*-xylylenediamines with various dibasic acids and the properties of salts have also been described. (*In Russian.*) Issledovanie v oblasti sinteza polimerov. I. Sintez poliamidov na osnove ksililendiaminov. ***S. R. Rafikov, B. A. Zhubanov, R. N. Khasanova, K. Z. Gumargalieva, and K. D. Sagintaeva.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 699-705.

* **Studies on the Mechanism of Radiation Polymerization. I. Mechanism of the Gamma-Ray Induced Polymerization of Isobutene and Styrene.** The gamma-ray induced polymerization and copolymerization of styrene and isobutene in ethyl chloride have been investigated at -78° and 0° and monomer concentration 2.5 mole/l. The polymerization rate of styrene at -78° was 20.1×10^{-6} and of isobutene 14.1×10^{-6} mole/l sec. The copolymerization rate at -78° for all initial mixture compositions was less than the individual polymerization rate. Isobutylene does not polymerize at 0° and there is a different relation between the copolymerization rate and the initial mixture composition. (*In Russian.*) Izuchenie mekhanizma radiatsionnoĭ polimerizatsii. I. O mekhanizme karbonievoĭ polimerizatsii izobutilena i stirola pod deĭstviem gamma-luchei. ***A. P. Sheĭnker and A. D. Abkin.*** *Vysokomolekuliarnye Soedinenia,* v. 3, no. 5, May 1961, p. 716-723.

* **Isomorphous Substitution in Polyethyleneterephthalate.** It has been shown that the isomorphous substitution of adipic for terephthalic acid leads to increase in the degree of crystallinity and packing density of polyethyleneterephthalate. The authors explain this effect as due to an increase in flexibility of the macromolecular chains. Maximum density values of polyethyleneterephthalate containing ethylene adipate units are observed in the co-polyester synthesized with 2–4% (of weight of dimethylterephthalate) of dimethyl adipate. (*In Russian.*) Izomorfnoe zameshchenie v polietilenterftalate. ***B. V. Petukhov and S. M. Kondrashova.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 657-661.

* **Butadiene-Isoprene Copolymerization by Catalysts Prepared From *Co* Diacetylacetonate-Aluminum Diethyl Monochloride-Toluene.** (*In Italian.*) Copolimerizzazione del butadiene e dell'isoprene con catalizzatori ottenuti da cobalto diacetilacetonato-alluminio dietilmonocloruro-toluolo. ***I. Pasquon, L. Porri, A. Zambelli, and F. Ciampelli.*** *Chimica e l'Industria,* v. 43, May 1961, p. 509-512.

Formable Thermosetting Acrylic Polymers. Transparent thermosetting plastics suitable for use in high-speed military aircraft have been developed. Flat, essentially thermoplastic sheets at an intermediate stage of cure are prepared, which are stable for long periods at room temperature. Upon heating to 110-300 F these sheets can be stretched or formed in conventional molds. The cure of the formed specimens can be completed by heating to temperatures of 300-500 F. An intermediate treatment with ionizing radiation is required for the curing of stretched specimens. Optimum results were obtained with a two-component system containing diallyl itaconate and styrene and a five-component system containing diallyl itaconate, styrene, triallyl cyanurate, allyl methacrylate, and methyl methacrylate. ***Earl E. Parker and Thomas L. St. Pierre.*** *Modern Plastics,* v. 38, no. 10, June 1961, p. 133 + 6 pages.

Allylic Resins and Laminates. ***Harry Raech, Jr. and J. L. Thomas.*** *Modern Plastics,* v. 38, no. 10, June 1961, p. 143 + 3 pages.

Diffusion and Equilibrium Studies for the System Acrylonitrile-Styrene-Polyethylene. The solubilities of acrylonitrile and styrene in low-density polyethylene were measured at 0 and 27 C over the entire range of compositions. The ternary solubility data were analyzed in terms of the relationships developed by Krigbaum and Carpenter. It is shown that the behavior of the ternary system may be predicted from the Flory-Huggins interaction constants of the three pairs of binaries. The rates of desorption of acrylonitrile and styrene from 48 mil thick sheets of polyethylene were measured at 27 C. ***Horace W. Chandler and Ernest J. Henley.*** *A.I.Ch.E. Journal,* v. 7, no. 2, June 1961, p. 295-298.

* **Chain Transmission by Primary, Secondary and Tertiary Amines During the Radical Polymerization of Styrene and**

Vinyl Acetate. The rate of polymerization of styrene and vinyl acetate was measured in the presence of these amines. The relative radical-transmission constants of the amines were determined in the two monomers on the basis of the viscosimetrically determined molecular weight of the polymers. (*In German.*) Kettenübertragung durch primäre, sekundäre und tertiäre Amine bei der Radikalpolymerisation von Styrol und Vinylacetat. ***F. Hrabák and L. Jirešová.*** *Collection of Czechoslovak Chemical Communications,* v. 26, no. 5, May 1961, p. 1283-1292.

a

* **Influence of the Initiator on the Grafting of Polyvinyl Polymers.** The dependence of grafting on the type of initiator has been examined in the case of three polymer-monomer systems: polystyrene-methyl methacrylate, polymethyl methacrylate-vinyl acetate, and polyethyl α-chloracrylate-vinyl acetate. The different initiators used in these experiments were benzoyl peroxide (Bz_2O_2), azobisisobutyronitrile (AIBN), di-*tert*-butyl peroxide (DTBP), and *tert*-butyl hydroperoxide (TBHP). ***G. Smets, J. Roovers, and W. van Humbeek.*** *Journal of Applied Polymer Science,* v. 5, no. 14, Mar.-Apr. 1961, p. 149-152.

b

* **Unsaturation in Irradiated Marlex 50 Polyethylene: Dose Rate and Post-Irradiation Effects.** Infrared absorption spectroscopy has been used to demonstrate dose rate dependence of *trans*-vinylene unsaturation in irradiated Marlex 50 polyethylene. When the irradiated polymer is stored in vacuum a decrease is observed in *trans*-vinylene absorbance over a period of several weeks. After high dose rate irradiation the decay is preceded by an initial increase. These phenomena are ascribed to the reaction of "trapped" radicals. ***P. J. Fydelor and R. W. Pearson.*** *Journal of Applied Polymer Science,* v. 5, no. 14, Mar.-Apr. 1961, p. 171-174.

c

* **Cationic Polymerization and Copolymerization of Coumarone.** This polymerization at a low temperature in solution in halogenated hydrocarbides contributed to the preparation of soluble polymers having very high molecular weights. It was also possible to obtain copolymers with styrene, α-methyl styrene, indene, anethole and vinyl ethers. (*In French.*) Polymérisation et copolymérisation cationiques de la coumarone. ***Pierre Sigwalt.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 24, June 12, 1961, p. 3800-3802.

d

POLLUTION AND WASTES

* **The Gas Phase Reactions of Nitrogen Oxides With Olefins.** The nature of the condensation products formed in the gas phase reactions of nitrogen dioxide and nitric oxide with pentene-1, 2-methylbutene-2, and 2-methylbutadiene-1,3 was investigated. The reactants were combined at partial pressures in the range of 0.1 to 2.5 mm with the total pressure at one atmosphere. The products were determined by infrared and ultraviolet spectroscopy and colorimetry. ***Aubrey P. Altshuller, Israel Cohen, and Robert A. Taft.*** *International Journal of Air and Water Pollution,* v. 4, nos. 1-2, June 1961, p. 55-69.

e

* **Photochemical Reaction Products in Air Pollution.** When low concentrations of simple olefins and nitrogen oxides in air are irradiated with artificial sunlight, the olefin molecule splits at the double bond. One end forms a carbonyl compound, and the other yields a variety of products. Among these is a highly oxidized, unstable organic nitrogen compound previously described as compound X or peroxyacetyl nitrite (PAN) and detected in polluted atmospheres. This compound has now been purified by gas chromatographic techniques, and its chemical, physical, and physiological properties have been examined. At concentrations well below 1 p.p.m. in air, this compound produces damage symptoms on plants similar to those observed from oxidant air pollution but different in some respects from the phytotoxicant from ozone-olefin reactions. PAN is the first pure compound isolated from photochemical reaction mixtures which has been found to produce the characteristic oxidant damage symptoms. It is also a strong eye irritant at concentrations in the 1 p.p.m. range and is therefore probably responsible, along with acrolein and formaldehyde, for the eye irritation in photochemical air pollution. ***E. R. Stephens, E. F. Darley, O. C. Taylor, and W. E. Scott.*** *International Journal of Air and Water Pollution,* v. 4, nos. 1-2, June 1961, p. 79-100 + 4 plates.

f

* **Aerobic Sludge Digestion.** ***N. Jaworski, G. W. Lawton, and G. A. Rohlich.*** *International Journal of Air and Water Pollution,* v. 4, nos. 1-2, June 1961, p. 106-114.

g

* **Degradation of Nitrogen-Containing Organic Compounds by Activated Sludge.** Nutrient Broth, alanine, propyl amine, aniline, o-, m-, and p-amino Na benzoate, o-, m-, and p-nitro Na benzoate propionitrile, and benzonitrile were all found to be biologically degradable by activated sludge. 3,5-Dinitro Na benzoate and 2,4,6-trinito Na benzoate were not biologically degradable by activated sludge. The N-containing organic compounds which were biologically degradable released their N into solution during metabolism. Once in solution, this N could be used for synthesis. The mechanism removal of N from the organic molecule was the same regardless of the original form of the N group. The N group was converted to an amino group, if necessary, and was then hydrolyzed from the molecule as ammonia nitrogen. ***J. M. Symons, R. E. McKinney, R. M. Smith, and E. J. Donovan, Jr.*** *International Journal of Air and Water Pollution,* v. 4, nos. 1-2, June 1961, p. 115-138.

h

* **Some Observations on Smoke Plumes.** Observations were plotted in terms of appropriate nondimensional variables and compared with the observations of Bosanquet, *et al.,* as well as the theoretical results of Priestley and Sutton. Within about 1500 ft. from the source good agreement with theory was found. The asymptotic plume height was found to be given crudely by the formula: $z_s = 250 \frac{F}{U^3}$ where U is wind speed, F "flux of buoyancy", a variable proportional to heat flux. ***G. T. Csanady.*** *International Journal of Air and Water Pollution,* v. 4, nos. 1-2, June 1961, p. 47-51.

i

RELIABILITY ENGINEERING

* **Reliability. A Subject Bibliography.** Technical Report 61-1. ***Tibor Vincze, compiler.*** 60 pp. Feb. 23, 1961. Institute of Technology, Wright-Patterson Air Force Base, Ohio. (ZTL784.R3 Un3.14r Ref.)

j

Support of Fire Control Reliability by Automatic In-Flight Evaluation. Potential applications of this evaluation equipment extend to any radar-controlled gunlaying fire control system. The techniques are also applicable to shipboard and land-based heavy gun systems. ***Stuart T. Belden.*** *Aero/Space Engineering,* v. 20, June 1961, p. 30 + 3 pages.

k

* **Electronic Components for Computers. Determination of Failure Rates.** Even extensive laboratory tests cannot give complete confidence that the performance of electronic components will be adequate when actually in use in a computer. Nevertheless, it has been found that modest tests such as outlined, do give a welcome degree of assurance and allow many potential defects in components and component usage to be corrected during the design stage. ***L. Knight.*** *Electronic Technology,* v. 38, June 1961, p. 214-216.

Troubleshooter's Approach to Failure Analysis. Increased reliability—that's why you want to pinpoint any weak link in design. Authors tell where and how to look for the unexpected in the newer miniaturized designs. ***H. S. Dodge and R. G. Lull.*** *Product Engineering,* v. 32, no. 26, June 26, 1961, p. 41-45.

RUBBER AND ELASTOMERS

The Law of Vulcanized Rubber Friction. The investigation of the law of vulcanized rubber friction on smooth hard surfaces over a wide range of normal pressures from 1 to 200 kg/cm² has shown that Coulomb's formula applies in the small load region, and Thirion's formula in the region of larger loads. This conforms with the formula proposed earlier by one of the author's; this formula becomes the Coulomb's formula at small loads and Thirion's formula at large loads. ***G. M. Bartenev and V. V. Lavrentjev.*** *Wear,* v. 4, no. 2, Mar.-Apr. 1961, p. 154-160.

*** The Crosslinking Efficiency of Some Vulcanizing Agents in Natural Rubber.** The results indicate that dicumyl peroxide is a quantitative crosslinking agent for natural rubber, as was previously found to be true of dimethyloctadiene. As one molecule of dicumyl peroxide is able to form one crosslink, 3.2 to 4.0 molecules of tetramethylthiuram disulfide or 9-10 sulfur atoms in a sulfur-sulfeneamide system are needed for the same purpose. ***O. Lorenz and C. R. Parks.*** *Journal of Polymer Science,* v. 50, Apr. 1961, p. 299-312.

*** Chemical Modification of Vulcanizates. I. Reaction of Vulcanizates With Styrene, Methyl Methacrylate and Isoprene.** The reaction of comminuted vulcanizates with styrene, methylmethacrylate and isoprene at elevated temperatures has been investigated. It has been shown that preliminary ozonization of the vulcanizates exerts a considerable influence on the polymerization kinetics. A large part of the polymerized monomers has been found incapable of solution in solvents of the homopolymers, i.e. of forming chemical bonds with the vulcanizates. On this basis it has been suggested that the polystyrene, polyisoprene and polymethylmethacrylate copolymers with the vulcanizates contain graft polymers. (*In Russian.*) Khimicheskaia modificatsiia vulkanizatov. I. Vzaimodeĭstvie vulkanizatov so stirolom, metilmetakrilatom i izoprenom. ***B. A. Dogadkin, et al.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 729-733.

*** Thermal Decomposition of Fluorine Containing Elastomers of the Type Kel-F and PFP/VF. I.** The thermal decomposition of Kel-F and PEP/VF elastomers has been investigated over the temperature range 200-300°. It has been shown that heating of the fluorine containing elastomers in vacuum is accompanied by evolution of hydrogen halides and changes in the structure and color of the original substances. The reaction energy of HCI elimination from Kel-F type elastomer is 29 kcal and of HF elimination 34 kcal. The change in structure of the Kel-F polymer is insignificant at 200-250°. It is believed that perceptible "crosslinkage" of the polymer at the initial stages of its heating at 200 and 250° is associated with the presence of oxygen-containing groups. Degradation of the macromolecular chains of the Kel-F elastomer is observed at 300°, the polymer being converted to a black viscous mass. (*In Russian.*) Termicheskiĭ raspad ftorosoderzhashchikh elastomerov tipa Kel-F i PFP/VF. I. ***T. G. Degteva.*** *Vysokomolekuliarnye Soedineniia,* v. 3, no. 5, May 1961, p. 671-678.

*** The Cure of Chlorobutyl Blends With Other Rubbers.** Cure systems are described for blends with NR, SBR, CR, or NBR to obtain best balance of properties. ***G. J. Ziarnik, F. P. Ford, and J. T. Kehn.*** *Rubber World,* v. 144, no. 3, June 1961, p. 85-93.

*** The Rheological Properties of Cis-Polybutadiene.** Presented at the "Rubber and Plastics Age" Second International Synthetic Rubber Symposium held in London from 11th-13th, October 1960. ***D. Bulgin.*** *Rubber and Plastics Age,* v. 42, June 1961, p. 715 + 7 pages.

*** Elastomers for Advanced Design Flight Vehicles.** This paper was presented at the "Rubber and Plastics Age" Second International Synthetic Rubber Symposium held in London from Oct. 11-13. Particular problems of end products of materials research and fabrication of elastomeric components as well as the major task of improving the chemical, thermal, and mechanical properties of all compounded rubbers are discussed. ***R. E. Headrick.*** *Rubber and Plastics Age,* v. 42, June 1961, p. 705 + 5 pages.

*** A New Synthetic Elastomer Based on a Chlorophosphonated Polyolefin.** A new synthetic elastomer has been obtained based on an ethylene-propylene copolymer prepared using an organometallic catalyst system. Reactive sites (phosphonyl dichloride groups) are placed on the copolymer chain by treating the polymer with phosphorus trichloride and oxygen. After hydrolysis or alcoholysis of the phosphonyl dichloride groups to phosphonic acid or phosphonic acid esters, vulcanization may be carried out by reaction with metallic oxides, particularly lead oxide. Vulcanizates of the polyolefin elastomer have outstanding resistance to heat, ozone, and oxygen, and have excellent electrical properties. This combination suggests the use of this material in high temperature electrical applications. ***E. C. Leonard, Jr., W. E. Loeb, J. H. Mason, and W. L. Wheelwright.*** *Journal of Applied Polymer Science,* v. 5, no. 14, Mar.-Apr. 1961, p. 157-162.

*** Studies on the γ-Irradiation of Natural Rubber Latex.** Vulcanized latex was obtained by the γ-irradiation of natural rubber latex. The optimum cure was attained with ca. 2 x 10⁶ r, in the case of 40% latex. Owing to the acceleration action of the water present, rubber in latex crosslinked more easily than it did in previously dried latex film, but no appreciable difference was found between the crosslinking in latices of various water contents. The protein in the latex deteriorated under γ-irradiation, but the properties of the latex were not damaged. The maximum tensile strength of the film obtained by drying this irradiated latex was larger than that of solid rubber irradiated in air; this may correspond to the fact that the irradiation, even when carried out in air, brought about no side reactions such as oxidation, etc., of rubber in latex. The aging behavior of the irradiated film was quite superior, the tensile strength being greater after aging than before. ***Yuji Minoura and Mamoru Asao.*** *Journal of Applied Polymer Science,* v. 5, no. 14, Mar.-Apr. 1961, p. 233-239.

SOLID MECHANICS

*** Non-Linear Integral Equations of the Revolving Concave Shells.** The solution of equation reduces to the solution of infinite nonlinear systems of algebraic equations. As a first approximation, a shallow spherical shell at different boundary conditions, as well as a shallow ring-shaped spherical shell, is considered. (*In Russian.*) Nelineinye integral'nye uravneniia pologikh obolochek vrashcheniia. ***A. A. Berezovskii.*** *Inzhenerno-Fizicheskiĭ Zhurnal,* v. 4, no. 5, May 1961, p. 44-53.

Easier Answers for Stress When Curved Surfaces Touch. Because their contact area is small, stress is high. Here are two factors that simplify finding the stress. ***Robert I. Isakower.*** *Product Engineering,* v. 32, no. 25, June 19, 1961, p. 65-66.

Yield Strength of Machined Ring-Stiffened Cylindrical Shell Under Hydrostatic Pressure. The effects of initial imperfections and residual welding and rolling stresses on the yield strength of a stiffened cylinder were investigated by tests of a machined and stress-relieved model. ***M. E. Lunchick and J. A. Overby.*** *Experimental Mechanics,* v. 1, June 1961, p. 178-185.

Use of Electrical-Resistance Strain Elements in Three-Dimensional Stress Analysis. A method for constructing resistance-wire strain gages which may be imbedded in a plastic model without materially altering the stress pattern in the model is presented. The methods used to calibrate the gages, and the photoelastic tests made to investigate the effect of the gages on the stress pattern are described. The application of this new three-dimensional technique to evaluate the stress distribution in a thick-walled cylindrical pressure vessel is discussed. Correlation between experimental data and calculated values is given. ***R. I. Brasier and R. C. Dove.*** *Experimental Mechanics,* v. 1, June 1961, p. 186-191.

Stresses in a Deep Beam With a Central Concentrated Load. Presents the results of three photoelastic tests on simply supported deep beams carrying a central-point load. A comparison between the theoretical and experimental stress distribution is shown on a number of sections. ***Shawki Saad and Arnold W. Hendry.*** *Experimental Mechanics,* v. 1, June 1961, p. 192-198.

Pulsed-Air Vibration Technique for Testing High-Performance Turbomachinery Blading. A pulsed-air vibration exciter for testing turbomachinery blading is described. This exciter has been used successfully in performing blade-vibration studies at frequencies up to 15,000 cps. Higher-mode fatigue failures, both flexural and torsional, have been produced. Although capable of vibrating large blades, the exciter has been particularly useful in investigations of small blades having inherently high natural frequencies. The tester is capable of high-temperature operation. Operating experience using the pulsed-air exciter is presented, and examples of its application to engine-design problems are given. ***J. C. Truman, J. R. Martin, and R. V. Klint.*** *Experimental Mechanics,* v. 1, June 1961, p. 201-205.

* **Triangular Sectional Wedge With a Local Load Applied to a Section of the Wedge Face.** The plane problem in the theory of elasticity of radially divided triangular sectional wedge is considered. Within each layer the elastic characteristics are constant. (*In Russian.*) Treugol'nyi sostavnoi klin pod deistviem mestnoi nagruski na uchastke grani. ***S. G. Shul'man.*** *Inzhenerno-Fizicheskiĭ Zhurnal,* v. 4, no. 5, May 1961, p. 81-84.

Slow Compression Crushing of Single Particles of Glass. Glass cylinders and spheres were crushed in a hydraulic press. In all experiments the elastic energy stored in the specimen prior to fracture was measured. ***William J. Kenny and Edgar L. Piret.*** *A.I.Ch.E. Journal,* v. 7, no. 2, June 1961, p. 199-202.

* **Compression Tests on Thin-Walled Cylinders.** Describes compression tests on eight thin-walled cylinders of 3 ft diam. and 0.035 in. wall thickness made of aluminum alloy plate. The lengths of the cylinders were either 6 ft or 9 ft. Three of the cylinders were tested under axial compression up to buckling failure, and the initial buckling load, failing load and mode of buckling were observed. Three other cylinders were similarly tested, but these cylinders were subjected to internal pressure before applying the compressive load. The internal pressure had a twofold strengthening effect on these cylinders. A parallel platen device was used in testing the last two cylinders (in an unpressurized condition) which restrained rotation of the end faces of the cylinders. These tests enabled the effect of end restraint to be studied, and also enabled measurements of load-carrying capacity at large axial deflections to be made. The initial buckling loads, failing loads and modes of buckling observed in the tests were compared with existing large deflection theory. ***M. Holmes.*** *Aeronautical Quarterly,* v. 12, pt. 2, May 1961, p. 150-164.

* **The Elastic Stress Concentration Factors in Shouldered Shafts. I. Shafts Subjected to Torsion.** The photoelastic "stress freezing" technique was employed to evaluate the elastic stress concentration factors associated with the fillet blend radius in a number of shouldered shafts. The full range of practical sizes of blend radius and depth of shoulder was examined. Comprehensive results for the shaft subjected to torsion, pure bending and axial load are given. The accuracy of the graphs of stress concentration factors is better than 6%. Comparison is made with the existing theoretical and experimental results for each mode of loading. The results of an investigation into the limiting value of the stress concentration factor (for a particular shoulder radius) as the depth of the shoulder is increased to infinity are included. ***I. M. Allison.*** *Aeronautical Quarterly,* v. 12, pt. 2, May 1961, p. 189-199.

Pressure Vessel Brittle Fracture and Information Required to Design Against It. Further study is required to extend the variety of vessels which may be safely designed. In particular, alloy steel vessels and new, potentially valuable welding processes require further assessment, particularly in test situations appertaining to pressure vessel service. ***A. A. Wells.*** *British Welding Journal,* v. 8, June 1961, p. 32s-36s.

On Transient Thermal Stresses in Viscoelastic Materials With Temperature-Dependent Properties. Deals with the quasistatic analysis of transient thermal stresses in the linear theory of viscoelastic solids with temperature-dependent properties. The underlying constitutive law rests on the temperature-time equivalence hypothesis. ***Rokuro Muki and Eli Sternberg.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 193-207.

Propagations of Elastic Waves Generated by Dynamical Loads on a Circular Cavity. The Fourier-transform technique has been employed to solve the exterior elastodynamic problem concerning the region outside a circular cavity in a plane elastic body. ***A. C. Eringen.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 218-222.

Stress Distribution on the Boundary of a Circular Hole in a Large Plate During Passage of a Stress Pulse of Long Duration. ***A. J. Durelli and W. F. Riley.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 245-251.

Experiments on the Postbuckling Behavior of Square Plates Loaded in Edge Compression. Experiments were carried out by using aluminum square plates, and the relations of the maximum deflection, stresses, and strains at typical points in the plate with applied loads were determined under four different boundary conditions. It is found that the experimental results are in reasonable agreement with those theoretically predicted. ***Noboru Yamaki.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 238-244.

Uniqueness in the Optimum Design of Structures. A procedure was developed previously for the determination of the optimum design of a sandwich shell or structure. The uniqueness of the optimum design obtained by this procedure is investigated, and it is shown that all optimum designs admit a common collapse mode. This result is used to prove the uniqueness of minimum-weight designs obtained in previous work. ***T. C. Hu and R. T. Shield.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 284-287.

Design of Thin-Walled Torispherical and Toriconical Pressure-Vessel Heads. Gives curves and a table useful for the design and analysis of the knuckle region of a thin torispherical or toriconical head of an unfired cylindrical vessel. ***R. T. Shield and D. C. Drucker.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 292-297.

A Modification of the Coulomb-Mohr Theory of Fracture. The modified theory is a three-parameter theory, but all three parameters in principle can be obtained from only two simple tests. ***Burton Paul.*** *ASME, Transactions, Series E, Journal of Applied Mechanics,* v. 28, no. 2, June 1961, p. 259-268.

* **Calculations of Random Fatigue of Hard-Spring Resonators.** Computations were made for the effect of a nonlinearity of the hard-spring type upon the fatigue damage ensuing on excitation of a resonator by a stationary, broad-band, random Gaussian force. The fatigue theory used assumes a simple accumulation of damage in proportion to a power of the peak values of response strain, without interactions between peaks. Two cases are distinguished: (a) strain proportional to displacement; (b) strain nonlinearly dependent on displacement, as is the surface fiber strain in a bar with pinned ends, responding in a single mode. Numerical results are presented that indicate for case (a) a continuous decrease, with increasing nonlinearity, of the rate of accumulation of damage, while for case (b) this damage rate increases to a maximum as large as 3.4 times the linear estimate, and then falls below the value for linear response. Probability density (in response amplitude) of damage is greater at small amplitudes, and less at large, than for the linear case. The value of response amplitude of maximum damage density is also affected by nonlinearity. ***P. W. Smith, Jr.*** *Acoustical Society of America, Journal,* v. 33, June 1961, p. 752-756.

SOLID STATE PHYSICS

* **Magnetoelectric Effect in Chromium Oxide.** The magnetization in a Cr_2O_3 single crystal produced by an electric field is investigated. In accordance with the predictions of the theory the magnetization is found to be proportional to the field. The proportionality coefficient measured at 20 C is $4.3 \cdot 10^{-4}$. In the temperature range from 310 to 80 K, the magnetic moment along the third-order axis and the magnetic moment in the basal plane have opposite signs. (*In Russian.*) Magnitoelektricheskii effekt v okisi khroma. ***D. N. Astrov.*** *Zhurnal Eksperimental'noĭ i Teoreticheskoĭ Fiziki,* v. 40, no. 4, Apr. 1961, p. 1035-1041.

Paramagnetic Resonance Spectra of f^2 Ions in a Cubic Site. The paramagnetic resonance spectra of Nd^{3+} and U^{3+} in the cubic field of CaF_2 have been investigated at 3 cm at 20 K. In the case of Nd^{3+} transitions within the lowest quartet $\Gamma_8(^2)$ and possibly in the next higher quartet $\Gamma_6(^4)$ have been observed. The angular behavior conforms with that predicted by Bleaney's formulism of the spin Hamiltonian of a Γ_8 state. In the case of U^{3+} there are considerable deviations of the experimental g values from the calculated ones. It is suggested that these deviations are caused by the stronger cubic field. The efficiency of the thermal conversion from axial to cubic site is discussed. Additional lines suggest a new axial center along the [111] direction. ***G. Vincow and W. Low.*** *Physical Review,* v. 122, 2nd ser., no. 5, June 1, 1961, p. 1390-1392.

Electron Microscope Observation of Precipitates on Grown-In Dislocations in MgO. The defect structure of undeformed, single-crystal, Norton MgO has been examined by transmission in the electron microscope. It is observed that precipitate particles in the form of 0.2-μ diam spheres and short rods are present in large numbers on as-grown dislocations. By using special etching and optical techniques which are described, the concentration of the precipitate spheres is shown to average 10^9 "balls"/cc (but range from 10^7 to 10^{10} "balls"/cc) for a large number of samples examined. Qualitative evidence is presented which indicates that these precipitates are the origin of Tyndall scattering frequently observed in MgO. ***J. D. Venables.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1388-1389.

Effect of Temperature and Doping on the Reflectivity of Germanium in the Fundamental Absorption Region. The 2.1- and 4.4-ev peaks in the reflectivity spectrum of Ge have been studied as a function of temperature and doping. The temperature coefficient of the 2.1-ev peak is -4.2×10^{-4} ev/K, that of the 4.4-ev peak -1.8×10^{-4} ev/K. Large donor concentrations give a decrease in the energy gap at the zone boundary in the [111] direction which is nearly the same as the shrinkage of the thermal gap. No shift with doping of the 4.4-ev peak was detected. The spin-orbit splitting of the valence band at the L_3' point in the zone boundary was found to be 0.18 ev. ***Manuel Cardona and H. S. Sommers, Jr.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1382-1388.

Theory of Magnetostriction in Cobalt-Manganese Ferrite. The magnetostrictive effect of an orbitally degenerate magnetic ion in a cubic ferromagnet is calculated in detail using crystal-field theory. In contrast to our previous work, it is not assumed that interatomic exchange energy is large compared with spin-orbit energy. The results are applied to the effect of cobalt in cobalt-manganese ferrite. It is found that the theory is consistent with experimental results for the magnetostrictive parameters λ_{100} and λ_{111} in the compound $Co_{0.245}Mn_{0.747}Fe_{1.99}O_4$ from 225-355 K. By fitting theory to experiment, a trigonal splitting of about 630 cm^{-1} for the ground state of the cobalt ion is inferred. The trigonal splitting has less than half its value in cobalt-iron ferrite. ***John C. Slonczewski.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1367-1372.

Fluorescent Response of Scintillation Crystals to Heavy Ions. The light output of CsI(Tl) was measured as a function of energy for incident ions of B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, and F^{19}. The response of NE 102 plastic and anthracene scintillators was also measured for ions of N^{14} and O^{16}, respectively. The response of CsI was essentially linear for energies above 6 Mev/A, where A is the mass number of the incident ion. The NE 102 was linear for energies above 4 Mev/A. The anthracene data showed slight curvature even at 9 Mev/A. It would appear that the response of CsI differs somewhat among crystal samples. ***E. Newman, A. M. Smith, and F. E. Steigert.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1520-1524.

Magnetoresistance of Oriented Gray Tin Single Crystals. The electronic band structure of gray tin was investigated through magnetoresistance measurements on oriented *n*- and *p*-type single crystals at 77, 195, and 273 K. From these measurements the low-field magnetoresistance coefficients were evaluated. Magnetoresistance anisotrophy was observed in *n*-type crystals at 195 and 273 K, but was not observed in either *n*- or *p*-type material at 77 K. Two possible explanations for the temperature-dependent anisotropy are proposed. ***O. N. Tufte and A. W. Ewald.*** *Physical Review*, v. 122, 2nd ser., no. 5, June 1, 1961, p. 1431-1436.

*** The Effect of Unresolved Structures on the Line Width in Electron Paramagnetic Resonance.** The electron paramagnetic resonance line width in solid paramagnetic salts is calculated by taking into account the unresolved fine and hyperfine structures. (*In Russian.*) Vliianie nerazreshennykh struktur na shirinu linii v elektronnom paramagnitnom rezonanse. ***R. Kh. Timerov.*** *Zhurnal Eksperimental'noĭ i Teoreticheskoĭ Fiziki*, v. 40, no. 4, Apr. 1961, p. 1101-1105.

*** Use of Indirect Transitions in Semiconductors for Determination of States With Negative Absorption Coefficients.** The conditions for formation of states with negative temperature in semiconductors have been obtained for indirect transitions of nonequilibrium carriers in the following two cases: indirect recombination of free carriers; and indirect recombination from exciton states. Possible mechanisms of absorption of radiation are considered and the conditions for appearance of a negative absorption coefficient are derived by taking these processes into account. (*In Russian.*) Ispol'zovanie nepriamykh perekhodov v poluprovodnikakh dlia polocheniia sostoianii s otritzatel'nym koeffitsientom pogloshcheniia. ***N. G. Basov, O. N. Krokhin, and Iu. M. Popov.*** *Zhurnal Eksperimental'noĭ i Teoreticheskoĭ Fiziki*, v. 40, no. 4, Apr. 1961, p. 1203-1209.

*** A Contribution to the Interpretation of the Anisotropy of the Resistance Change of *n*-Conductive InSb.** InSb crystals, obtained by the Czochralski method and containing more than $10^{16} cm^{-3}$ Te, often exhibit a change in resistance. In specimens with a current direction *I* parallel to the direction of growth, the change in resistance is more than one order of magnitude higher than in specimens with I vertical to the direction of growth. This situation was confirmed in the case of the directions of growth [111], [100], and [113]. (*In German.*) Zur Deutung der Anisotropie der Widerstandsänderung von n-leitendem InSb. ***H. Rupprecht.*** *Zeitschrift für Naturforschung*, v. 16a, Apr. 1961, p. 395-401.

*** Polarization Measurements of the Absorption Spectrum of Methylene Blue.** The absorption spectrum of methylene blue was studied with the aid of low temperature spectroscopy and foil method from the point of view of the number, position, and direction of polarization of the electron bands. From the nine absorptions definitely found, six possess a transition moment in the long axis of the molecule, two are vertically polarized to this, whereas it was impossible to determine the oscillator position of the short wave bands. (*In German.*) Polarisationsmessungen am Absorptionsspektrum des Methylenblaus. ***Julius Kern and Friedrich Dörr.*** *Zeitschrift für Naturforschung*, v. 16a, Apr. 1961, p. 363-366.

*** Materials for Semiconductor Technique.** Studies the degree of purity of semiconductor materials, doping, contacting, production of semiconductor metals (Ge, Si, In, Ga, Al, Se, and Te, B), the fields of use for diodes, transistors, rectifier, optical instruments, blocking layer photoelectric effect, selective light transfer, their moelectric apparatus, resistances sensitive to heat. (*In German.*) Werkstoffe für die Halbleitertechnik. ***W. Schreiter.*** *Technik*, v. 16, Apr. 1961, p. 305-310.

Microwave Isolator Combines Hall Effect and Tunnel Diodes. Solid-state hall plates, immersed in static magnetic fields, can be combined with shunt resistors to yield unidirectional circuit elements or isolators. If negative shunt resistors are used, the isolator can be made lossless, or even provide forward amplification. ***C. H. Hubbard, L. A. LoSasso, and E. Rousso.*** *Electronics*, v. 34, no. 24, June 16, 1961, p. 56-57.

High-Frequency Power in Tunnel Diodes. An expression for high-frequency tunnel-diode power is developed with a simple dissipative load, and for signals confined within the nearly linear range of the diode negative resistance. The existence of maximum power output for a given frequency of operation, and for an optimum peak current-to-capacitance ratio is demonstrated. The power and the inductance appear in the equations as a product, and consequently, the higher-power output diodes require the lower inductances. The results are plotted for germanium as well as for gallium arsenide in the form of charts with the ratio of peak current-to-capacity and the operating frequency as coordinates. ***G. Dermit.*** *I.R.E. Proceedings*, v. 49, June 1961, p. 1033-1042.

*** Dynamical Theory of Ultrasonic Attenuation in Metals.** A detailed investigation is given of the ultrasonic attenuation governed by dynamical properties of conduction electrons. It is pointed out that the ultrasonic attenuation arises from the same mechanism that is also responsible for the attenuation of collective oscillations in a conduction electron system, known as Landau's attenuation in some case. Applying the electro-magnetic dispersion relations in metals to the problem in hand, the attenuation constants are derived, and at the same time, the effects of conduction electrons on sound velocities are investigated. Some discussions are given of the relation between the results obtained and those of Pippard. ***Noboru Takimoto.*** *Progress of Theoretical Physics*, v. 25, no. 3, Mar. 1961, p. 327-352.

* **The Theory of Superconductivity in the Tamm-Dancoff Approximation.** The Tamm-Dancoff approximation is applied to the interaction Hamiltonian used by Bogoliubov in his theory of superconductivity. It is shown that the requirement that there is no virtual production of a single pair of electron and hole without phonons, or the electron-phonon coupling parameter tends to zero, leads to essentially the same compensating equation as obtained by Bogoliubov. ***B. P. Nigam.*** *Progress of Theoretical Physics*, v. 25, no. 3, Mar 1961, p. 436-440.

Miniature Hall Probe Maps Magnetic Fields. Describes miniature Hall-effect probe for mapping small, sharply discontinuous ferromagnetic structures, having field intensities of less than 0.01 gauss. ***D. D. Roshon, Jr.*** *Electronics*, v. 34, no. 24, June 16, 1961, p. 68 + 2 pages.

* **Photo-Stimulated Emission of Exo-Electrons From Anode-Oxidized Layers of Aluminium.** It is found that photo-stimulated emission of exo-electrons can be obtained from Al_2O_3 layers by anode-oxidation of aluminum with AC current or by appropriate thermal processing. The long-wave limit of the photoemission observed lies within the visible spectral region. The method utilized in oxidizing the Al surface was found to affect the intensity of electron emission. The emission is considered to be due to centers resembling the F centers in alkali halides. ***Tadeusz Lewowski.*** *Acta Physica Polonica*, v. 20, no. 2, 1961, p. 161-166.

Semiconductor Devices. III. Discusses thermistors, voltage-sensitive resistors, Zener diodes, and point contact rectifiers. *Electromechanical Design*, v. 5, no. 6, June 1961, p. 45 + 16 pages.

The Emittance of Coated Materials Suitable for Elevated-Temperature Use. Compiles original test data taken from the literature published during the period 1940 to 1959, inclusive, and from as much of the 1960 literature as could be obtained. Covers boride, carbide, oxide, and silicide coatings and enamels and paints. ***W. D. Wood, H. W. Deem, and C. F. Lucks.*** *Battelle Memorial Institute, Defense Metals Information Center, DMIC Memorandum* 103, May 4, 1961, 138 pp. (TN799 B32.2d Contin.)

* **Relationship Between the Electric Dark Conductivity and the Green Luminescence of ZnO Crystals.** The luminescent emissivity of the green emission, and the electric conductivity of synthetic Zn oxide crystals with different doping, are determined by measurements with light and potential sounds. A reaction kinetic interpretation of the correlation between these two values is given. Measurements of the fading time are given and discussed. (*In German.*) Über den Zusammenhang zwischen der elektrischen Dunkelleitfähigkeit und der grünen Lumineszenz von ZnO-Kristallen. ***E. Mollwo.*** *Zeitschrift für Physik*, v. 162, no. 5, Apr. 1961, p. 557-569.

Detection of Millimetre and Sub-Millimetre Wave Radiation by Free Carrier Absorption in a Semiconductor. Shows that, with a suitable semiconductor, at a low temperature, this effect can be made the basis of a detector for millimeter and sub-millimeter wave radiation of high sensitivity and short time constant. ***B. V. Rollin.*** *Physical Society, Proceedings*, v. 77, pt. 5, May 1961, p. 1102-1103.

* **Solid-State Research at Low Temperatures. III. Thermal Conduction in Insulators; Paramagnetism; Dielectric Losses Related to Chemical Lattice Imperfections.** ***J. Volger.*** *Philips Technical Review*, v. 22, no. 8, 1960-1961, p. 268-277.

* **The Main Dielectric Constants of the Homogeneously Arranged Crystal-Liquid Phase of *p*-Azoxyanisole.** In high-purity 4.4'-di-methoxy-azoxybenzene (*p'*, *p'*azoxyanisole) the main dielectric constants ϵ_1 and ϵ_2 and the dielectric anisotropy $\Delta\epsilon$ of the nematic crystal-liquid phase were measured at 0.10; 0.26; 0.65; and 1.60 megacycles. For practical purposes, the molecular main polarization values were calculated from index of refraction measurements and the dipole moment and its orientation in the molecule was determined by the dielectric constant data. (*In German.*) Die Hauptdielektrizitätskonstanten der homogen geordneten kristallin-flüssigen Phase des *p*-Azoxyanisols. ***W. Maier and G. Meier.*** *Zeitschrift für Naturforschung*, v. 16a, May 1961, p. 470-477.

The Electrical Resistivity of $ZrZn_2$. Electrical resistivity measurements on the ferromagnetic intermetallic compound $ZrZn_2$ between 2.2 K and 295 K fail to show an anomaly at the ferromagnetic transition such as are observed in other ferromagnetic elements and compounds. ***C. E. Olsen.*** *Physics and Chemistry of Solids*, v. 19, nos. 3-4, May 1961, p. 228-229.

An Upper Limit for the Resistivity of a Superconducting Film. Studies the question of whether the resistance of a superconducting film of thickness comparable with the depth of penetration is truly zero. ***R. F. Broom.*** *Nature*, v. 190, June 10, 1961, p. 992-993.

A Miniature 90x10 Solid State Multiplexer. The evaluation of a completely solid state electronic multiplexer, with a capacity of 90 channels, is presented. Electrical operation is described as well as mechanical fabrication. A comparison of two types of packaging techniques is made. ***S. G. Kritzstein and A. V. Ottaviano.*** *IRE Transactions on Product Engineering and Production*, v. PEP-5, no. 2, June 1961, p. 29-37. (TK1 In6.6p Vis.)

* **Transverse Galvanomagnetic Effect of Bismuth Single Crystal in a Strong Magnetic Field.** Effects of Bi single crystal are measured in a strong field up to about 100 kilo Oersted at 4.2, 3.0, and 1.8 K., and the 12 components of the galvanomagnetic tensor are obtained with respect to the magnetic field dependence. Furthermore, the behaviors of the galvanomagnetic tensor components near the quantum limit of the magnetic quantization are studied, supposing that they lead to analysis of the energy band structure. In a strong magnetic field, the amplitudes of the oscillatory part of the galvanomagnetic tensors are nearly temperature independent, and the behaviors of the Hall effect appear to be different from the expected one from the classical theory of the two-bands model. ***Kunihide Tanaka, Seiichi Tanuma, and Tadao Fukuroi.*** *Tôhoku University, Science Reports of the Research Institutes, Ser. A. Physics, Chemistry, Metallurgy*, v. 13, no. 2, Apr. 1961, p. 67-81.

* **Solid-State Electronic Instruments for Measurement and Control.** Discusses the over-all design of a system based on separable modular units, and describes some of the electronic techniques employed. ***I. C. Hutcheon and G. B. Marson.*** *Instrument Engineer*, v. 3, no. 3, Apr. 1961, p. 49-60.

Note on Hydromagnetic Waves in a Compressible Fluid Conductor. If the anisotropic nature of motion of an incompressible, inviscid, and perfectly conducting medium of infinite extent embedded in a uniform magnetic field is strongly manifested by undistorted propagation of waves in one direction only—along magnetic lines of force—the compressibility acts in a strange manner. ***John Carstoiu.*** *National Academy of Sciences, Proceedings*, v. 47, June 1961, p. 891-898.

* **Electrical Conductivity of Germanium With Lithium Impurity at Low Temperatures.** ***I. A. Kurova and N. D. Tyapkina.*** *Soviet Physics - Solid State* (Cover-to-cover translation of *Fizika Tverdogo Tela*), v. 2, June 1961, p. 2761-2764.

* **Use of the Theory of Damping in Calculations of Kinetic Coefficients.** Theory of damping in the form suggested by L. van Hove is used in calculations of arbitrary kinetic coefficients, both in the presence and in the absence of a weak magnetic field. Explicit general expressions are obtained for kinetic coefficients in the limiting case of weak interactions between flow carriers and scattering particles. In the important particular case of elastic anisotropic scattering, described by the relaxation time tensor whose main axes are oriented arbitrarily relative to the main axes of the effective mass tensor, specific formulas are obtained for a whole series of effects (galvano- and thermomagnetic effects, magnetooptical effects, Faraday effect, etc.). ***M. I. Klinger.*** *Soviet Physics - Solid State* (Cover-to-cover translation of *Fizika Tverdogo Tela*), v. 2, June 1961, p. 2747-2760.

* **Concerning the Possibilities of the Reaction $Si + 2CO \rightleftarrows SiO_2 + 2C$ in the Steelmaking Process.** On the basis of thermodynamic considerations, the possibility for this reaction to occur in the degasing process of molten steel is discussed. In the presence of a system formed by FeO, Fe, C, CO, Si, SiO_2 and for temperatures equal to or higher than the temperature of initial solidification of the steel, the conditions necessary for the reaction to take place in a measurable way do not occur. (*In Italian.*) Sulla possibilita' della reazione: $Si + 2CO \rightleftarrows SiO_2 + 2C$ nel processo di fabbricazione dell'acciaio. ***Agostino Bargone.*** *Tecnica Italiana*, v. 26, no. 3, Apr.-May 1961, p. 173-178.

* **The Evaluation of "Esaki Integrals" and an Approximate Expression for the Tunnel-Diode Characteristic.** Fermi-Dirac-type integrals, involving a product of two density-of-states functions in the integrand, have been first considered by Esaki. Two series expressions, suitable for computation, have been derived for such integrals, appropriate for room temperature and low temperatures respectively. A simple analytical current-voltage characteristic for the tunnel diode has been obtained, which has approximately the same degree of validity as Esaki's original theory. ***T. P. Brody and R. H. Boyer.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 209-215.

The Carrier-Recombination Behavior and Annealing Properties of Radiation-Induced Recombination Centers in Germanium. ***O. L. Curtis, Jr. and J. H. Crawford, Jr.*** U. S. *Atomic Energy Commission, ORNL*-3108, June 1, 1961, 116 pp. (UF767 U3o Contin.)

Replacing Sine Wave Sources With Solid-State Inverters. An inverter can replace a sine-wave source if its square-wave output is modified to have the same rms and average values as a pure sine wave. A uniform method is presented here with a discussion of design problems. ***Donald Levy.*** *Electronics,* v. 34, no. 26, June 30, 1961, p. 80-83.

* **Alpha Cutoff Frequency of Junction Transistors.** The alpha cutoff frequencies of drift and diffusion transistors are analyzed and approximated by simple analytical expressions. ***J. Lindmayer and C. Wrigley.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 247-258.

* **Injection Electroluminescence.** A survey of promising host-crystal materials is given, and the unusual difficulties encountered in making junctions in wide-band-gap materials are pointed out. *p-i-n* Junctions offer a more favorable approach to efficient injection El than *p-n* junctions. The properties of varied band gaps at the contacts will be described. A discussion of sources of loss will be given. ***Albrecht G. Fischer.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 232-246.

* **The Potentialities of Silicon and Gallium Arsenide Solar Batteries.** The theory of the spectral response of a *p-n* junction solar battery unit is given, and detailed comparisons are made of the expected performance of silicon and gallium arsenide units. ***T. S. Moss.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 222-231.

* **Molten-Diffused Silicon Transistors.** Impurities are diffused from the molten semiconductor directly into the single-crystal bulk. This single-crystal-producing method was given the name "molten-diffused process". With the application of this process, it has become possible to obtain silicon transistors with a base width less than 1μ and a cut-off frequency of 580 Mc/s. This paper reports on the transistors so produced. ***Shoji Tauchi.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 216-221 + 1 plate.

* **A Low-Resistance Ohmic Contact for Silicon Semiconductor Devices.** A low-resistance ohmic contact to lapped silicon can be obtained by a displacement plating of Au followed by an electrodeposition of Cu. ***S. L. Matlow and E. L. Ralph.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 202-208.

* **Direct Recombination in GaAs and Some Consequences in Transistor Design.** Experiments are presented indicating that the recombination rate R in GaAs is given by the expression $R = Bpn$. The theory of Hall for direct transition is used to calculate the value of B as 1.4×10^{-10} cm^3/sec. Practical GaAs transistors are shown to be feasible if base widths of 1μ are used. ***S. Mayburg.*** *Solid State Electronics,* v. 2, no. 4, May 1961, p. 195-201.

* **Measurement of the Optical Constants of Beryllium Oxiacetate on the Basis of the Reflection Spectrum Between 650 and 899 cm^{-1}.** This spectrum was interpreted by means of a Drude dispersion formula with only one term, whose different parameters were determined by several methods. The optical constants then calculated were adjusted so as to obtain a satisfactory agreement between the calculated reflecting power and its experimental value. (*In French.*) Mesure des constantes optiques de l'oxyacétate de béryllium, à partir du spectre de réflexion, entre 650 et 900 cm^{-1}. ***Claude Deloupy.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 21, May 24, 1961, p. 3221-3223.

SPACE HEATING AND CONDITIONING

* **Effects of the Electrical Charge on the Coagulation of Dust.** Describes a method to measure the relationship between the electrical charge and the coagulation of a dust cloud under constant climatic conditions. The distribution of the rates of vertical descent is measured with an electrical recording microbalance according to Gast. At the same time, the state of charge of the whirled-up dust is recorded by a double condenser and two electrometer amplifiers. Some initial results are given. (*In German.*) Einfluss der elektrischen Aufladung auf die Koagulation von Staub. ***Hermann Schnitzler and Josef Somolyai.*** *Staub,* v. 21, June 1, 1961, p. 241-246.

Providing Better Air for Bottled Up Men. Tabulates the substances identified or suspected of being present in air in submarines, space vehicles, or other enclosed areas. ***Eugene A. Ramskill.*** *SAE Journal,* v. 69, June 1961, p. 80-81.

How Dust Filter Selection Depends on Electrostatics. Electrostatic behavior of both dust and filter fabric, and their rate of charge dissipation, exert a profound effect on filter operation. ***Edward R. Frederick.*** *Chemical Engineering,* v. 68, June 26, 1961, p. 107-114.

* **Aircraft Refrigeration Systems.** Cooling problems, advantages of air and vapor cycle units and proposed systems for a supersonic transport. ***D. J. Leech.*** *Aircraft Engineering,* v. 33, June 1961, p. 156-163.

* **Mechanical Drifting With Air Cooling in a Hot Potash Mine.** Gives processes in the system of air circulation, description of the air-conditioning plant in use, operating conditions, and operational results. (*In German.*) Maschineller Streckenvortrieb mit Wetterkühlung in einer heissen Kaligrube. ***Harald Meyer.*** *Neue Hütte,* v. 6, Apr. 1961, p. 242-251.

* **Keeping Cool at High Speeds.** Reviews a French aeronautical invention which offers much promise for future adoption. ***G. G. O. Manton.*** *Aeronautics,* v. 44, no. 2, June 1961, p. 43.

* **Miniature Air Filters for Airborne Applications.** ***Irwin Balaban.*** *Sperry Engineering Review,* v. 14, no. 2, June 1961, p. 16-21.

* **The Subjective Rating of Motor Vehicle Noise.** A subjective experiment is described, which was designed to establish a relationship between the subjective rating of noise emitted by motor vehicles, and objective measurements made with a sound-level meter employing "A" weighting. The results show that in the case of private cars and commercial vehicles satisfactory correlation is obtained between the subjective and objective measurements. ***C. H. G. Mills and D. W. Robinson.*** *Engineer,* v. 211, June 30, 1961, p. 1070-1074.

TEXTILES, FIBERS, LEATHER, AND PAPER

* **Tanning Studies With Dialdehyde Starch. Preliminary Evaluation of the Leather.** Tanning with dialdehyde starch oxidized to the 96% level, at p^H 10 and oiling the leather in general resulted in the optimum leather properties and characteristics for this tannage. ***E. M. Filachione, et al.*** *American Leather Chemists Association, Journal,* v. 56, May 1961, p. 200-212.

* **The Drying of Web Materials.** Reviews recent developments in paper drying, so as to present the various approaches to the problem of high-capacity, high-speed drying that seem possible at the present time. A total of 71 references is given, covering: theory of drying, research on the mechanisms of drying, dielectric heating, radiant heating, vacuum drying, flash drying, high velocity dryers, drying by fluidized bed techniques, drying with molten metal. Each of the drying techniques described in these references is considered from both a theoretical and economic viewpoint. ***B. W. Burgess.*** *Pulp and Paper Magazine of Canada,* v. 62, June 1961, p. T303-T309.

THERMAL MECHANICS

The Coal-Burning Closed-Cycle Gas Turbine. Existing plants reveal gratifying results. The cooling water can be used for area heating, and the simplicity of operation promises successful use in isolated, self-controlled plants. ***C. Keller and W. Gaehler.*** *Mechanical Engineering,* v. 83, June 1961, p. 61-67.

Turbofan Engines Extend Range of DC-8. Performance and capabilities of the turbofan jet engines. ***William S. Reed.*** *Aviation Week and Space Technology,* v. 75, July 10, 1961, p. 50 + 2 pages.

* **Some Chemistry of Future High-Compression Engines.** Future of high-compression Otto-cycle engines; knock; precombustion; combustion chamber deposits; surface ignition; incomplete burning; side reactions; and chemical aids. ***Wheeler G. Lovell.*** *Institution of Mechanical Engineers, Automobile Division, Proceedings,* 1959-1960, no. 4, 10 pp. + 2 plates.

* **Nonpropulsive Power Systems for Long-Time Space Applications.** At present, solar photocells are the prominent source of power for long-time, nonpropulsive applications in space, and they will maintain this prominence for powers below a kilowatt or so. Thermoelectric power supplies are being developed for use with solar, radioisotopic and reactor energy sources; these systems will be useful in those applications involving impact or long periods of darkness. Turbogenerator systems employing solar and reactor energy sources are being developed for powers of several kilowatts and up; their use for nonpropulsive applications is several years away. Thermionic emitters are the basis for promising future systems, but their real potential cannot yet be evaluated. ***B. Lubarsky and R. E. English.*** *Canadian Aeronautical Journal,* v. 7, no. 6, June 1961, p. 243-251.

Vertical Floating Launch of Rocket Vehicles. Project Hydra—a study of handling, erection, acceleration, effects, and checkout concepts applicable to water launch. ***J. E. Draim and C. E. Stalzer.*** *Aero/Space Engineering,* v. 20, June 1961, p. 12 + 7 pages.

Tomorrow's Power Sources. A survey of 14 basic power sources for portable use from 1 to 500 hp. ***Roy Kamo.*** *Product Engineering,* v. 32, no. 26, June 26, 1961, p. 51-60.

Trends in Aircraft Propulsion. ***H. Pearson.*** *Royal Aeronautical Society, Journal,* v. 65, June 1961, p. 373-388.

Another Go-Around for the Rotary Engine. The latest rotary engine development is an English product, known as the Selwood. A description of its operation and pictures are contained in this article. *Machine Design,* v. 33, June 22, 1961, p. 24-25.

Boiling-Water Void Distribution and Slip Ratio in Heated Channels. Distribution of void and the behavior of slip ratio in light water in a rectangular heated test section were investigated using a beta-particle-attenuation technique in support of the joint U. S.-Euratom program on development of economic nuclear power systems. The amount of void in the subcooled region was determined to within ± 3% void. The slip ratio at a high Reynolds number is much more a function of the Reynolds number than of pressure. Furthermore, for Reynolds numbers between 50,000 and 90,000, the slip ratio at constant void fraction reaches a maximum. ***James J. Foglia, et al.*** *U. S. Atomic Energy Commission, BMI-*1517, May 31, 1961, 34 pp. (UF767 U3b Contin.)

* **Anomaly of the Temperature Distribution in the Surface Layers of a Heated or Cooled Wall.** In connection with an increase of temperature in the surface layer of a conducting plate subjected to a constant thermal flux, the linear increase of the surface temperature as a function of time appears, once the flux has been applied, after a much longer delay than indicated by the theory. Thus a coefficient of overincrease or underdecrease in temperature has been associated with the flux. (*In French.*) Anomalie de la distribution de température dans les couches superficielles d'une paroi chauffée ou refroidie. ***Jean Jacq and Marcel Chateau.*** *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences,* v. 252, no. 21, May 24, 1961, p. 3201-3203.

Plasma Stability Analysis Employing Equilibrium Constants of Motion. A first step in analyzing the stability of solutions of the Vlasov equation governing hot plasmas of low density is to solve the linearized equation for the perturbed space and velocity distribution function in terms of the perturbed electric and magnetic fields. This report presents an explicit Green's function solution for the distribution together with two examples of its use. The Green's function is found by first transforming to equilibrium constants of motion as variables, and thus the method is similar to that of Bernstein, who employed constants of motion in solving for the distribution by direct integration. ***T. K. Fowler.*** *U. S. Atomic Energy Commission, ORNL-*3123, June 9, 1961, 16 pp. (UF767 U3o Contin.)

Verification of Nozzle Admittance Theory by Direct Measurement of the Admittance Parameter. The nozzle boundary condition on a gas-filled chamber experiencing harmonic pressure oscillations can easily be expressed if the so-called admittance ratio of the nozzle is known. This quantity is defined as the ratio of velocity to density fluctuations expressed in complex representation. Fair agreement was found for the imaginary part of the admittance, which is not affected by temperature oscillations. ***Luigi Crocco, Rodolfo Monti, and Jerry Grey.*** *ARS Journal,* v. 31, June 1961, p. 771-775.

Selection of a Pressurization System for a Storable Liquid Propellant Rocket Engine. A study was performed to select a propellant tank pressurization system for a high performance storable liquid propulsion system. Minimum weight and long term storability were desired. The systems proposed included four stored gas systems and eight generated gas types. The stored gas systems differ in the method of heating the gas. The generated gas systems differ in the generant employed and the method of controlling gas temperature. These systems are described and compared as to weight, component-development problems, and performance characteristics. Compatibility between pressurizing gas and liquid propellant, and its effect on system selection, is discussed. Stored gas system weight is shown highly dependent on storage bottle material and safety factor assumptions. Selection was based primarily on minimum weight but tempered by considerations of degree of development required. Comparison leads to selection on a dual gas generator system. ***C. J. Kaplan.*** *ARS Journal,* v. 31, June 1961, p. 786-793.

WELDING AND JOINING

* **Percussive Welding Does the Finest Work.** When soldering is not good enough, when resistance welding can not do the job, percussive welding can often save the day—producing highly reliable joints, even when welding fine wires in hard-to-get-at places. ***W. A. Owczarski and A. J. Palmer.*** *American Machinist,* v. 105, June 12, 1961, p. 114-116.

* **Investigation of Aging Processes of Welded Joints of Two-Phase Titanium Alloys. II. Aging of Joints Subjected to Heat Treatment.** Studies the kinetics of aging of hardened joints of three alloys of the VT6 type, differing in the β-stabilizing elements contained, on the basis of measurements of hardness and electric resistance, and of dilatometric, electron microscopic and radiographic investigations. (*In Russian.*) Issledovanie protsessov stareniia svarnykh shvov dvukhfaznykh titanovykh splavov. II. Starenie shvov, podvergshikhsia termicheskoĭ obrabotke. ***V. F. Grabin, S. M. Gurevich, V. A. Rafalovskiĭ, and V. I. Trefilov.*** *Avtomaticheskaia Svarka,* v. 14, no. 6(99), June 1961, p. 3-13.

* **Effects of Continuous Heating at 350-600 C on the Impact Strength of Austenitic-Ferritic Welded Joints.** The initial ferritic content of the joints studied substantially lowered the impact strength and raised the degree of embrittlement of the weld. In the entire interval of the aging temperatures from 350-600 C the decrease of the impact strength took place in a first stage up to 1000 hours. In a second stage up to 2000 hours, the impact strength was gradually leveled off, and no noticeable effect occurred during the third stage up to 5000 hours. (*In Russian.*) Vliianie dlitel'nogo nagreva pri 350-600° na udarnuiu viazkost' austenitno-ferritnykh svarnykh shvov. ***S. V. Iunger,***

M. P. Mel'nikov, and V. I. Logvinov. *Avtomaticheskaia Svarka,* v. 14, no. 6(99), June 1961, p. 14-20.

* **Equipment for Precision Electron Arc Welding of Heat Resisting Metals and Alloys.** An electron-optical system was designed with changeable electrodes 3.0, 4.2 and 5.4 in diameter, permitting an adjustment of the power used in welding from 100 W to 10 kW. The feeding sources, a high voltage rectifier and modulator, made possible welding under pulse conditions. An experimental assembly was formed for the welding of metals by means of an electron beam, with application to circular, angular and longitudinal joints. (*In Russian.*) Oborudovanie dlia pretsizionnoĭ elektronno-luchevoĭ svarki tugoplavkikh metallov i splavov. ***V. V. Gorbanskiĭ, L. V. Shubin, and A. F. Khubyshev.*** *Avtomaticheskaia Svarka,* v. 14, no. 6(99), June 1961, p. 21-30.

* **Electron-Arc Welding Guns.** Describes a welding gun of the spherical type for the formation of a sharply focused beam of electrons at 20 kV and 10 mA. The diameter of the focal spot of the gun on the surface of the welded part was equal to about 0.5 mm. The conductivity was $1.1 \cdot 10^{-2}$ A/kV 3/2, the power up to 20 kVA at 20 kV. The specific power of the beam on the welded surface was 6 - 8 kVA/mm^2. (*In Russian.*) Elektronno-luchevye svarochnye pushki. ***O. K. Nazenko.*** *Avtomaticheskaia Svarka,* v. 14, no. 6(99), June 1961, p. 31-36.

* **New Welder Joins Odd Shapes.** Describes a contour-welding machine which needs only a new set of control cams to produce regular welds on almost any irregular contour. *American Machinist,* v. 105, June 26, 1961, p. 74-75.

* **Technical and Economical Effectiveness of Different Methods of Welding Rollers.** Welding rollers under a ceramic flux with a Sv-08A wire is most economical since it ensures the lowest cost of 1 kg of the welded metal and nearly the same stability of the rollers as that of a powder wire and of a wire E1701. In order to estimate the economy of the methods used one must take into account such elements as the losses during welding, the reduction of the roller consumption, the reduction of the standstill of the roller equipment during the change of rollers, the increase of the production of the roller equipment due to a large diameter of the rollers, and the improvement of the quality of rolling. (*In Russian.*) Tekhniko-ekonomicheskaia effektivnost' razlichnykh metodov naplavki prokatnykh valkov. ***N. K. Sokolova.*** *Svarochnoe Proizvodstvo,* 1961, no. 5, May, p. 19-21.

* **Resistance to Intercrystalline Corrosion of Seams of Thin Sheets of Stainless Steel Welded in a Carbonic Acid Gas Medium.** Welds of stainless steel 1Kh18N9T (nearest AISI equivalent 321), 1 to 3 mm in thickness, made in the medium indicated and using welding wires Sv-1Kh18N9T, and the methods A and AM GOST 6032-58, exhibited resistance against intercrystalline corrosion immediately after welding, but were not corrosion-resistant after tempering at 650 C during two hours. The welds possess high plasticity (bending angle 180°); they practically equal the basic metal in strength. (*In Russian.*) Stoĭkost' protiv mezhkristallitnoĭ nerzhaveiushcheĭ stali, svarennykh v srede uglekislogo gaza. ***V. A. Savchenkov and V. I. Trubilko.*** *Svarochnoe Proizvodstvo,* 1961, no. 6, June, p. 28-30.

* **Investigation of Some Special Features of the Technique of Argon-Arc Welding of Aluminum and of Its Alloys With Steel.** A technique was developed for the argon-arc welding of Al and of its alloys with steel with the help of a transition layer of pure Al welded on steel coated with Al or Zn. This technique is a partial solution of the problem of arc welding in the case of these metals and allows the production of welds with limited strength. (*In Russian.*) Issledovanie nekotorykh osobennostei tekhnologii argonodugovoi svarki aliuminiia i ego splavov so stal'iu. ***G. A. Bel'chuk.*** *Svarochnoe Proizvodstvo,* 1961, no. 5, May, p. 8-11.

* **Thermal Cycle in the Welding and Beading of Sheets With Arcs Drawn Apart.** Analyzes the total temperature field for the selection of satisfactory conditions of two-arc welding and multilayer beading. Makes recommendations for the calculation of the speed of temperature change and for the selection of the time interval between the action of the successive arcs. The use of supplementary arcs drawn apart in front according to the direction of welding (beading) decreases considerably the speed of change of temperature in the interval calculated. (*In Russian.*) Termicheskiĭ tsikl pri svarki i naplavke listov razdvinutymi dugami. ***V. A. Shebanov.*** *Svarochnoe Proizvodstvo,* 1961, no. 6, June, p. 12-15.

* **Arc Welding of Thin Materials (MIG Process).** New equipment used for short-arc welding with inert-gas shielding is described and the advantages of this process for welding thin materials discussed. ***G. A. Scott.*** *Australian Institute of Metals, Journal,* v. 6, no. 2, May 1961, p. 90-98.

* **The Characteristics and Fabrication of Plastic-Metal Laminates.** The process of bonding plastic materials to metals is described. ***E. J. Williams.*** *Australian Institute of Metals, Journal,* v 6, no. 2, May 1961, p. 83-89.

MISCELLANEOUS

How to Listen . . . and Remember. III. Note-Taking . . . How and Why. *Product Engineering,* v. 32, no. 25, June 19, 1961, p. 64.

* **Vector Analysis.** The reasoning and premises involved in developing vector analysis are ideal as an exercise in adopting and appreciating a true mathematical frame of mind, and for discouraging the need for relating concepts to the obvious physical world. As links and ports of entry to some of the complexities of the real physical world, however, vector and the more general tensor analysis are among the foremost of the various domains of mathematics. ***Mary L. Boas and Julius J. Hupert.*** *Electro-Technology,* v. 67, no. 6, June 1961, p. 91-110.

* **Scientific Manpower Research.** Discusses research being done on educational backgrounds of American scientists. ***Lindsey R. Harmon.*** *National Academy of Sciences, News Report,* v. 11, no. 2, Mar.-Apr. 1961, p. 17-21.

Social Change in Science and Engineering. Scientists and technologists are in the midst of an enormous social experiment, involving the growth of many new skill groups and the undertaking of very large and complex R and D projects. Differences between engineers and scientists are examined in the context of the "research and development explosion". Traditional functional differences are being erased, but some differences in personal and social characteristics are described. ***Herbert A. Shepard.*** *IRE Transactions on Engineering Management,* v. EM-8, no. 1, Mar. 1961, p. 11-14.

Industry Objects to FDA Proposals. Chemical spokesmen feel that proposed regulations go beyond intent of new Federal Hazardous Substances Labeling Act. *Chemical & Engineering News,* v. 39, no. 25, June 19, 1961, p. 36.

* **Weberian r. Welfare Bureaucracy in Traditional Society.** Data from the Turkish coal industry suggest that the western bureaucratic model with its structural and behavioral elements of efficiency, rationality, and control rests upon certain normative assumptions about time, man and motivation. When such values are absent or when they are sharply challenged by the objectives of "welfare bureaucracy", the mere existence of "highly bureaucratized" organizations, as often seen in traditional society, tells us little about their operational consequences. Where social values do not assign a high priority to objectivity, productivity, and economic gain, the manifest structure of bureaucracy is of little relevance as a guide either to its performance or to its "reals" goals. ***Robert V. Presthus.*** *Administrative Science Quarterly,* v. 6, no. 1, June 1961, p. 1-24.

* **Inhomogeneous Markov Chains.** Discusses some new results related to ergodic and limit theorems, and also to the repeated logarithm low for inhomogeneous Markov chains. Theorems are formulated and proved for conditions that were not treated in the literature; some estimates obtained previously by S. N. Bernstein are employed. (*In Russian.*) Neodnorodnye tsepi Markova. ***T. A. Sarymsakov.*** *Teoriia Veroiatnosteĭ i ee Primeneniia,* v. 6. no. 2, 1961, p. 194-201.